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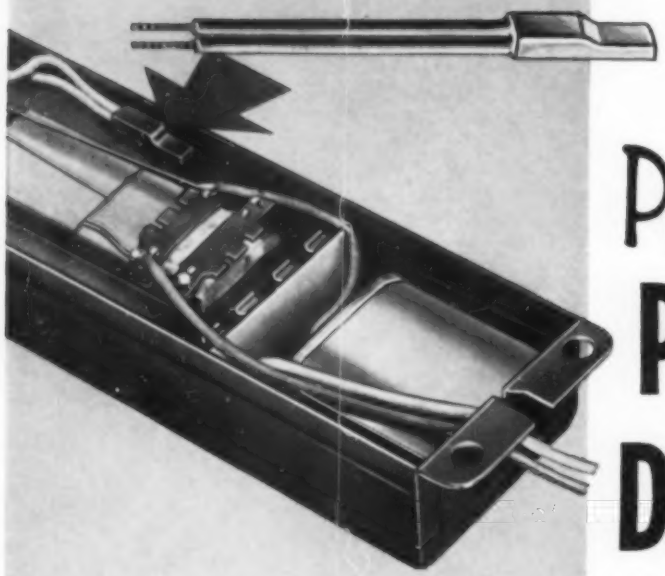

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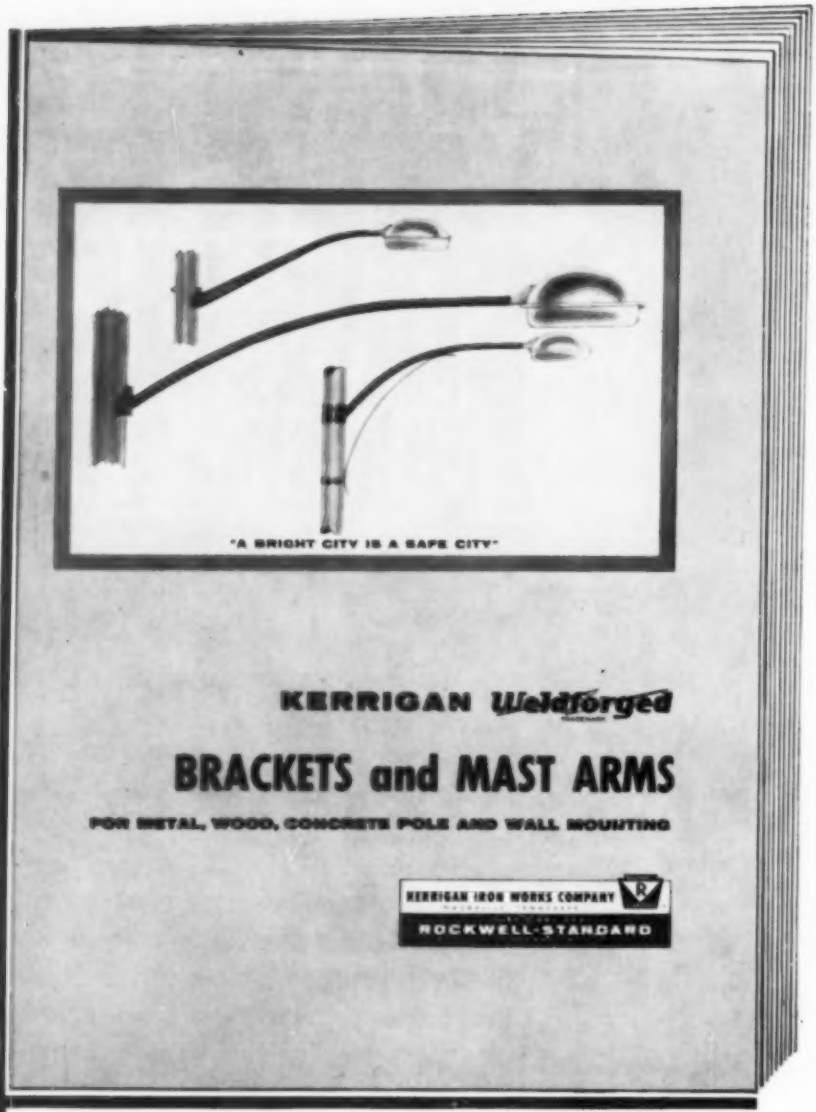
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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

July 1961

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Contents

415 More Ideas for a Lighting Man's File
Rx for a Doctor's Office, 415; New Direction for Tool Rooms, 417; New Angle for Kitchen Soffits, 418

419 Research in Lighting

423 Economics of Engineered Lighting—L. G. Parks

430 Modern Lighting Boosts Sales

435 IES Lighting Data Sheet—Series XXVI
Industrial Lighting (3-45)

436 Fog on Runways—Domina Eberle Spencer

443 Fog on Turnpikes—Domina Eberle Spencer

448 IES Lighting Data Sheet—Series XXVI
Lighting a Garage Wash Area (10-36)

449 Light Source with Long-Duration Flash—Steve B. Gibson and Stanley M. Segal

455 IES Lighting Data Sheet—Series XXVI
Lighting a Florist Shop (12-121)

457 IES Guide for Measurement of Photometric Brightness (Luminance)

463 IES Lighting Data Sheet—Series XXVI
Lighting a Bowling Center (20-39)

7A Lighting News
Here and There with IES Members, 6A; Scheduled Events, 13A; About People, 22A; It Seems to Me, 24A; New Members, 34A

27A IES Officers, 1961-1962

43A 1961 National Technical Conference

44A Index to Advertisers

Committee Personnel—Refer to April 1961 Illuminating Engineering

Sustaining Members—Refer to Section I, March 1961 Illuminating Engineering

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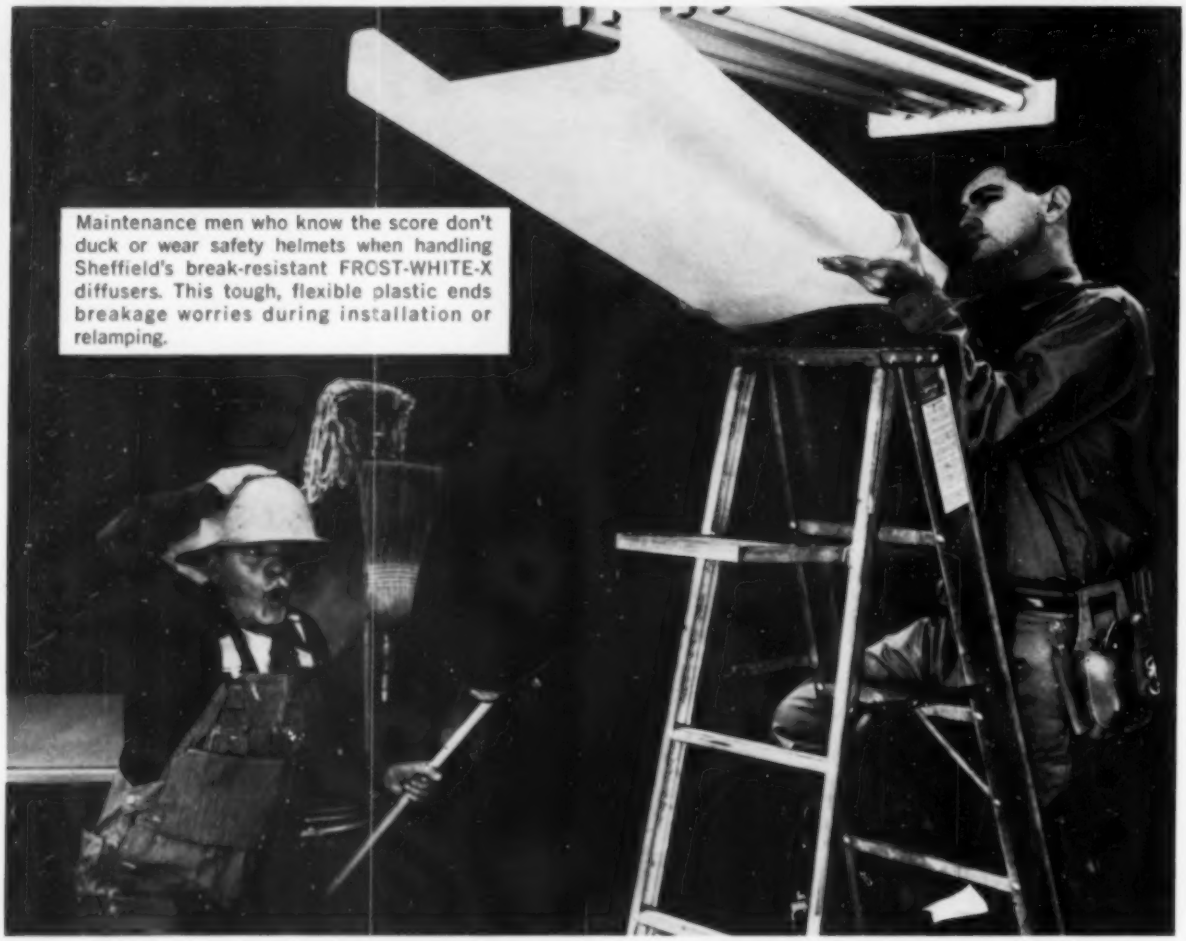
EXCESSIVE BREAKAGE A PROBLEM?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MORE IDEAS . . .

for a lighting man's file

Rx for a Doctor's Office

Tension and anxiety are not exactly unknown emotions in a doctor's office. That most doctors have this in mind, is evidenced by the warm, home-like decor of their offices. The aim is to achieve a familiar and, hopefully, relaxing atmosphere. As any lighting man knows, the right illumination design can play an important part in the success of the easeful surroundings.

At the same time, of course, a doctor's office also has demanding seeing needs for examination, minor surgery, etc. For Dr. William E. DiSanto of Norristown, Pa., this doctor's dilemma was solved by the lighting designed for him by Charles W. McQuiston, of the Philadelphia Electric Co., Philadelphia, Pa.

In his consultation room, Dr. DiSanto has two lighting systems at his disposal. One, planned for across-the-desk consultation, provides a comfortable 45 footcandles at the desk area. This is from

Figure 1. Dual-purpose consultation room. Direct-indirect unit suspended over desk has decorative touch in colored plastic center panel. Examination light (background) provides 250 footcandles over examining table.

a stem-mounted luminaire which uses two 48-inch deluxe cool white rapid-start lamps (see Fig. 1). Although this is a standard commercial fixture, its design lends itself pleasantly to the subdued modern decor of the room. Note the design which provides both up and downlight in the room. A center panel of colored plastic eggcrate, lighted diffusely by the indirect illumination from the ceiling, adds a decorative note.

Within the same area, the doctor may switch on a four-foot by eight-foot module unit—and have 250 footcandles of illumination for examination of the patient. This unit, which is directly above the examination table (see Figs. 1 and 2), is again of standard equipment—but applied for a specific seeing need.

Eight rows of conventional four-foot fluorescent channels are surface mounted in tandem units on six-inch centers. These are equipped with deluxe cool white fluorescent lamps. A valance board designed to conform with the decor of the room encloses this arrangement, and forms a plenum which measures 18 inches in depth The diffusing media employed are two-foot by four-foot vinyl plastic panels, in an inverted T-bar suspension system. The result is a neat, decorative extended area ceiling system providing 250 footcandles of well-directed, comfortable illumination.

A separate more official examination room (not shown) has its own high-level lighting system. This uses four-lamp 48-inch commercial fixtures, installed in an L-shaped pattern to fit the contour of the room. These units, which deliver 200 footcandles of working light for the doctor, are equipped with low brightness lens diffusers for the comfort of the patients. Similar care, to provide both high levels and patient comfort, has been applied in other areas, such as the treatment room, recovery room and corridors.

The operating room is illustrated in Fig. 3. The lighting design for this area uses the same system and fixture as the examination room, that is, four-lamp 48-inch surface-mounted luminaires. In this case, they are on four-foot centers in two continuous rows, three units per row. This arrangement yields 250 footcandles.

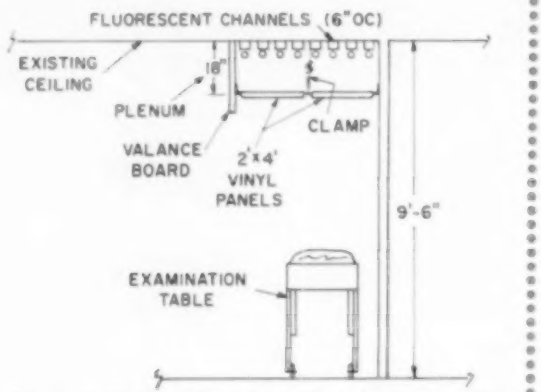


Figure 2. Details of the "custom-built" examination light, using standard equipment.

Figure 3. Operating room has general lighting level of 250 footcandles from low-brightness, surface-mounted luminaires in continuous rows on four-foot centers.

Tool room at Wallace and Tiernan, Inc., before (below) and after (right) the installation of a direct-indirect lighting system. Measured initial illumination level after relighting was in excess of 140 footcandles.

New Direction for Tool Rooms

To the lighting engineer, part of the pleasure in a successful installation is overcoming the obstacles. In a relighting job they are almost a certainty and in some areas can be very formidable indeed, as in this tool room at Wallace and Tiernan, Inc., Bellville, N. J.

The unorthodox system used for this job so successfully meets the lighting objectives (in spite of the obstacles) that it may well be a forerunner of things to come for industrial application.

One objective was, of course, levels to IES recommended practice; *i.e.*, a minimum of 100 footcandles on the task at all times. Another objective, for this task of tool design, was to virtually eliminate shadows and reduce specular reflections to an absolute minimum. Obstacles were prominent, to be sure. The 9-foot 11-inch ceiling was cluttered with girders which projected two feet down into the room every 10 feet. This broke the area into small cubicles of about 10 by 25 feet.

SOLUTION

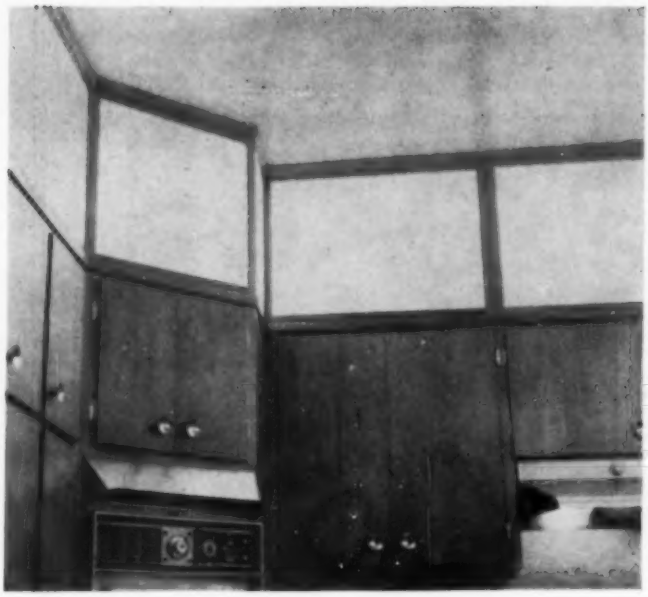
A system having a very high indirect component seemed to be the logical solution for the quality and control required. A direct-indirect illumination system is normally more associated with libraries, offices and schools than tool rooms. Even more unusual is the use of such a system for areas requiring in excess of 100 footcandles. As applied for this intallation, however, this system has successfully achieved both.

Equipment used consists of a single-lamp five-inch by five-inch cross-section, tandem suspended luminaire equipped with 1500-ma lamps, and a plastic eggerate (half-inch dimensions) diffuser. The distribution from this fixture is approximately 67 per cent upward and 33 per cent downward. The units, for two lamps and associated transformer, are approximately 18 feet long and are suspended on a simple hook and chain suspension for shock absorption, flush with the bottom of the girders. The fixtures are fed with a cord and plug attached to the old outlets on a four-inch octagon box in the branch circuit. Two of the two-lamp units are installed in each bay, which measures 10 feet by 25 feet. They are on five-foot centers. The total area covered by this installation is 6750 square feet. Naturally, the ceiling and upper walls were painted a high-reflectance white.

Initial illumination was in excess of 140 footcandles. With a good maintenance program, a maintained level of approximately 100 to 120 footcandles can be expected. This level, together with the high quality obtained from a direct-indirect system, has almost magically transformed the previously dismal shop.

Lighting design by A. S. Robinson, Silvray Lighting, Inc., Bound Brook, N. J.

New Angle for Kitchen Soffits



Soffits with "sculptured" panels make eye catchers of dust catchers in the kitchen shown in the above photograph. The idea was used in a remodeled apartment located in San Francisco's fashionable Pacific Heights neighborhood.

While only the kitchen is pictured here, a similar technique proved to be equally successful over cupboards in the bedroom. An interesting continuity in the lighting-decoration scheme was carried out throughout the apartment by using the same type of sculptured panel for luminous ceiling installations in the bathroom and in the combination gallery-and-hall.

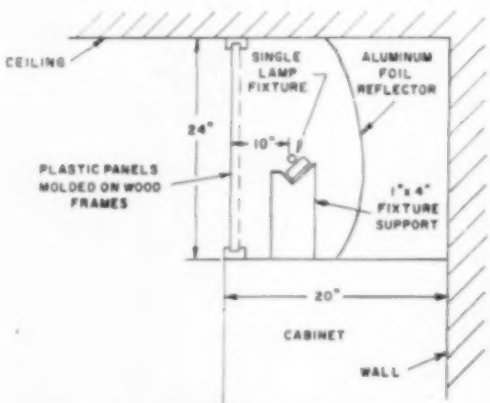
The vertical soffit idea solved two problems at once. First, the owner wanted as much general illumination as possible which would still blend with the architecture and not appear "commercial." Second, the high ceilings of the old house were to be retained throughout.

The kitchen is U-shaped, approximately 12 feet wide and 12 feet long. Besides good general illumination on the counters and floor center, the owner wanted lighting deep inside the cabinets.

The solution was the use of soffit space created between the cabinets and the high ceiling. The accompanying sketch shows how this was done. Ten 40-watt rapid-start single-lamp fixtures were placed around the perimeter of the kitchen, mounted ten inches behind the plastic, and enclosed with an aluminum foil reflector. Fixture installation and maintenance costs were reduced by laying the fixture on a one-inch by four-inch support, as is shown in the sketch. The wooden frames for the plastic panels were individually fitted by the carpenter to match the cabinet doors. A vinyl diffusing plastic panel with a "basket-weave" imprint was then molded on the frames. The diffusing panels have relatively low (300 footlamberts) brightness. The frames were made to snap into place, making easy periodic maintenance possible. Finally, the ceiling was painted an off-white for good reflection.

The soffit lighting creates a pleasing luminous wall effect, and the cabinets are well lighted deep inside. Lighting design provides 20 footcandles at the room center, 40 footcandles over the sink and range, and 20 footcandles on the counters.

Lighting design by William C. Nanny, Lumitex Luminous Panel Co., San Francisco, Calif.



Cross-section sketch of soffit lighting.

RESEARCH IN LIGHTING

What's going on in the research activities of the Illuminating Engineering Research Institute? Quite a bit, judging from the recent report to IES Council on IERI work for the past year. Some of the highlights of this report are summarized here.

DURING 1960, research work was concentrated on six areas of light-and-sight inquiry. Not all of the answers are available yet, but encouraging progress is reported leading to answers to the following six questions.

> ***How much illumination is needed on roadways at night to permit drivers to see obstacles and stop their vehicles safely from speeds of approximately 40 miles per hour? (IERI Project 30 G-1)***

The study seeking an answer to this question has been a project of Dr. H. Richard Blackwell, head of the Institute for Research in Vision at Ohio State University. Initially, Dr. Blackwell had confined his studies to indoor tasks. Late in 1958, however, he began to apply his measuring technique to outdoor seeing tasks, particularly to determining the amount of light autoists require to see various types of objects at various distances on roads and highways at night.

One of the by-products of his experiments on the highways in and around Columbus was the development of a modified Disability Glare Meter with which researchers could measure the losses of contrast due to disability glare normally found in roadway lighting systems.

As roadway obstacles Dr. Blackwell used a mannequin approximately the size of an 11-year-old girl, simulated black and white terriers, and other items such as bricks, tin cans, and "holes in the road." He discovered that the *contrasts* in the viewing task—mannequin, dogs, etc.—against the background of the road varied appreciably with relatively minor displacement of the task between luminaires spaced at 100-foot distances on alternate sides of the road. Therefore, he developed a new technique of evaluating roadway visibility with his instrumentation.

From Dr. Blackwell's measurements, it begins to appear that the curb lanes of four-lane roads (the lanes which pedestrians enter to cross the road) require almost twice as much light for safe and effective vision as do the driving lanes of the roadway.

Dr. Blackwell's report, which is not yet complete, found that new lighting installations in downtown areas of many cities "are about right" for effectively seeing roadway obstacles from moving vehicles. Such installations deliver about two footcandles and more.

> ***What are the lighting needs for substandard eyes? (IERI Project 30-J)***

The research work on this question is underway at the University of Ohio (Columbus), conducted by Mrs. O. Martenson Blackwell (the distaff side of the famous Blackwell team).

Instrumentation for Mrs. Blackwell's study of abnormal or subnormal eyes, and their reaction to levels of light, was developed under a grant from the IERI. It is called a recording discriminometer, and it enables the researcher to measure the subject's visual acuity. The use of this instrument is provided for under a grant from the National Institutes of Health.

Many interesting and eventually valuable experiences are being collected through this research, concerning the reaction to different levels of light by eyes having various defects. For example, the acuity of eyes having only rods, no cones (an hereditary abnormality not too rare), will at first be increased with more light, but only temporarily. Soon the acuity is actually decreased. As another example, some patients with only blue cones can

see better under other levels or color of light.

When all the numerous different reactions (to light) of various optical disease factors are known and classified, it should be possible to prescribe an appropriate lighting formula for patients in the same manner that a prescription can now be written for correctional lenses.

> ***To what extent do light sources—glass-walled buildings and homes with large picture windows—create glare problems, and how can such discomfort be controlled? (IERI Project 59-B)***

The first phase of this work has already been published (see "A Study of Glare from Very Large Sources," ILLUMINATING ENGINEERING, May 1960, page 288). The studies have been carried on simultaneously by Dr. R. G. Hopkinson at the Building Research Station in Garston, England, and Mr. Robert Bradley at Cornell University, Ithaca, N. Y.

Further analysis of the data already collected is now underway by Dr. and Mrs. Hopkinson (Mr. Bradley has withdrawn from the project because of illness). Even at this stage of analysis, however, it appears that the report will caution that limited brightnesses are necessary to avoid discomfort from high levels of brightness from large sources. Brightnesses as seen through large windows might have to be sharply reduced. Another observation is certain to be that such high-level large sources are more tolerable when surrounding brightness is increased.

> ***What can be done, through the control of reflected glare, to improve efficiency of work in schools, offices and other places where we read and write? (IERI Project 70)***

The present studies were begun by the late Benjamin Pritchard at Ohio State University and have since been taken over by other members of Dr. Blackwell's research team. The project rounded out many years of study of reflected glare. Its object is to study factors by which reflected glare can be minimized for office and school tasks.

More than a decade ago, lighting scientists believed that they had solved the problem of reflected glare in writing and reading materials when they recommended that writing and printing paper have dull, matte finishes and that walls and desks in classrooms, offices and other places where reading and writing is done be nonglossy.

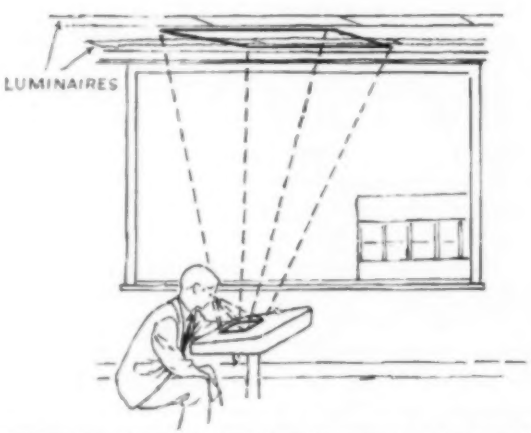
More recently, however, it was discovered that despite these precautions, a great amount of visual efficiency was being lost due to glare; that students and office workers could not see to their full capabilities. The degree of loss in a typical schoolroom in Toronto was shown in previously-reported studies conducted by John Chorlton and Hedley Davidson. They measured glossy reflections from three systems of lighting and found less glare from indirect lighting. In general, their data on the loss of seeing efficiency because of reflections in printed and written materials was confirmed by Professor D. M. Finch, at the University of California, who used physical measurements of the same reading task tested in Toronto.

So far, the researchers have found that a small improvement can be made toward reducing the loss of contrast due to reflected glare by polarizing the light being emitted by the overhead lighting equipment. Further, it is being found that a good potential for reducing contrast loss lies in redistribution of light—in decreasing amounts in the potential glare zone and increasing amounts in nonglare zones.

> ***How do sudden brightness changes affect ability to see detail? (IERI Project 63)***

In looking suddenly from one brightness area to another which is several times as bright, there is a serious loss in the ability to see. This was the finding of Dr. Robert N. Boynton, professor of psychology at the University of Rochester (New York), who conducted this project. The problem of "transitional adaptation" that Dr. Boynton dealt with in his study is a phenomenon experienced when we look quickly away from a brightly-lighted area and transfer our attention to a darker area, or vice versa. In his laboratory, Dr. Boynton approximated this condition so that he could measure the extent of the loss of the ability to see.

Dr. Boynton found that:



Project 70—Increased visual performance in schools and offices can be expected from reduction of reflected glare.

Table I—Color Preferences Indicated by Helson Study (Project 48).

ITEM	COLORS LIKED MOST				COLORS LIKED LEAST			
	MEN		WOMEN		MEN		WOMEN	
	2854K INC.	6500K FL.	2854K INC.	4500K FL.	6500K INC.	3000K FL.	6500K INC.	3000K FL.
Butter		x		x		x	x	
Beef (raw)	x			x	x		x	
Apples	x			x		x		x
Lettuce	x		x		x		x	
Tomatoes	x		x			x		x
Faces	x		x		x			x

Inc.—Incandescent; Fl.—Fluorescent; K—Kelvin degrees.

- If there was a three-to-one change in brightness, he had a 15 per cent loss of contrast.
- If he had a ten-to-one change in brightness, he had a loss of 76 per cent in contrast.
- Adjustment equal to that achieved through change of contrast was attainable through change in letter size.

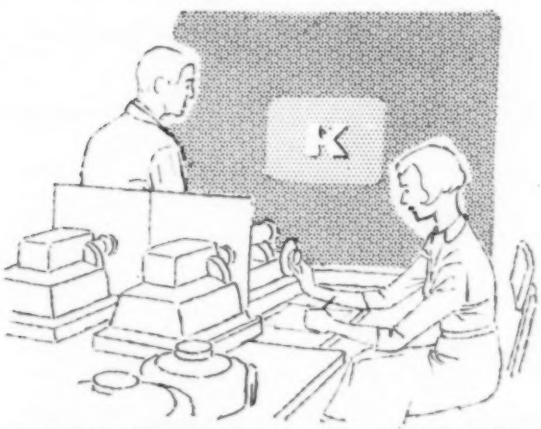
> ***In what respects are the pleasantness and comfort of the living and working environments affected by color and illumination? (IERI Project 48)***

Expressed in another way, this study seeks to find out what colors, if any, of furniture, background, food, etc., are most preferred by the most people, which are least preferred, and which are neutral. Further, under what kind of illumination are they considered pleasant, unpleasant, neutral, or whatever? The work has been conducted by Dr. Harry Helson, professor of psychology at the University of Texas (Austin). Dr. Helson recorded 156,250 color preferences for swatches placed against changing backgrounds, using as subjects five men and five women. His objective is to create a series of charts which would indicate families of color pleasantness; charts which would demonstrate which hues were best complemented by specific backgrounds and types of light.

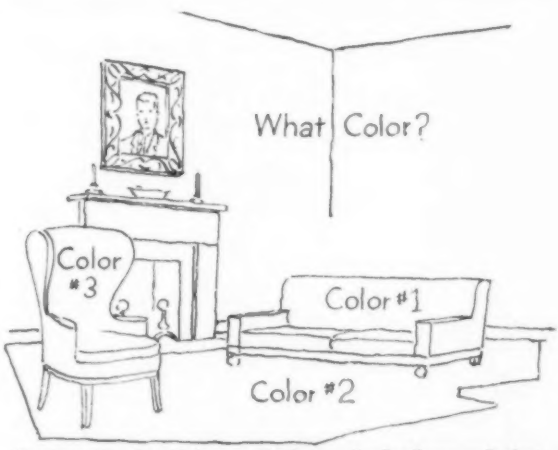
His final report will await extensive analysis of his data. In an interim report, however, he has revealed that there are preferred color combinations for use in our living and working interiors. Pleasantness, he said, depends upon the hue of the background against which the color is placed and the illuminant under which it is viewed. Table I shows color *vs.* illuminant for some everyday items.

FUTURE PROJECTS

In addition to further analysis, and finally publication of the projects just described, the Research Institute also has plans for several new research



Project 63—Visibility losses caused by sudden transitions in brightness are measured in Dr. Boynton's laboratory.



Project 48—Dr. Helson will chart color backgrounds that complement groups of foreground colors—and vice versa.

projects to be undertaken as personnel and/or equipment become available. Some of these are:

Project 30-I—Further Field Task Simulator Studies.

Installation of equipment and laboratory facilities is to be made soon, at Ohio State University (under Dr. Blackwell), for new measuring work with the Field Task Simulator (see ILLUMINATING ENGINEERING, June 1959, page 331).

It is anticipated that the new studies will involve scanning for spot defects anywhere in the peripheral area of certain of the discs (which are part of the device). This represents an increased complexity over earlier studies, which required observers to locate defects in the center of the discs only. In addition, the new conditions more nearly typify realistic inspection tasks which present defects practically anywhere on the subject.

An additional complexity involves the introduction of a different scanning pattern—the movement of the wheel being interrupted for a particular eye movement, and then being resumed until the next stoppage in the scanning pattern. This represents the type of scanning involved where work is done at a given position with no attendant rotation.

It is proposed that work on this project be done under four different light sources—incandescent, fluorescent, mercury, and possibly sodium.

Project 30-K—Extension of the Blackwell Curve

Under this two-year project the Blackwell Curve, which has been completed to include 300 footlamberts on the brightness scale, will be extended to 3000 footlamberts. This portion between 300 and 3000 footlamberts pertains to many of the more difficult seeing tasks in commerce and industry.

Work will be carried on in the controlled-brightness cubicle which Dr. Blackwell used for all of his basic studies of visual performance on static tasks.

Project 30-L—Varying Field Factors and APS

This study is designed to determine whether the present field factors (15) of the Blackwell Method of Task Evaluation, and the assimilations per second (5) vary for different tasks and conditions in commerce and industry. Recordings of eye movements probably will play a prominent role in determining these factors.

Project 30-M—Portable Visual Task Evaluator

A prototype of a portable Visual Task Evaluator was completed under Project 30-H, a 1958 contract. Upon use in the field, however, it was discovered that there were difficulties in screening out peripheral glare sources and in establishing a technique for making measurements under nonuniform background brightness conditions, such as those found in the roadway lighting which was the subject of Project 30-G-1. Experience gained in the roadway tests contributed improvements being built into the instrument resulting from this new project.

Project 47-E—Reflectance of Automobile in Fog

This project is an outgrowth of Project 47-C, visibility in fog (model study), upon which a report is expected soon. The work under Project 47-C developed the design of lighting for optimum visibility for a light-colored car (grey). Work under the new project will determine lighting modifications necessary for a dark-colored car (black).

Project 47-F—Model Study of Roadway Lighting

After the fog study in Project 47-E is completed, the model will be converted to simulate a roadway lighting installation, which will extend the work done outdoors under Project 30-G-1.

The purpose of this work is to obtain a comprehensive range of Visual Task Evaluator measurements upon which to base recommendations of lighting for streets and highways. In carrying this project forward, the researchers will have the benefit of consultation with representatives of the Bureau of Public Roads, the American Association of State Highway Officials, and the Highway Research Board.

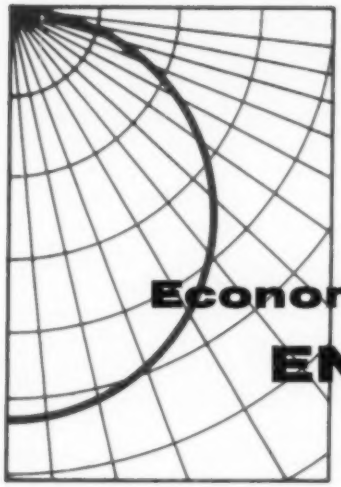
Project 49—Hot Spots in Luminaires

Dr. Fry and Dr. Fugate of Ohio State University have conducted a study (on discomfort glare from luminaires) from which they gathered data which now must be analyzed and extended. They will deal with subjective and physiological reactions resulting from brightness patches on lighting units, and will see if the reactions are related to the closure of the pupillary opening.

Project 63-B—Further Transitional Studies

This project extends the transitional adaptation work of Dr. Boynton, discussed earlier in this report. Dr. Boynton's studies thus far have extended from 0.4 to 40 millilamberts of brightness. Under the new contract, his studies will be continued at much higher levels of brightness—from 40 to several thousand millilamberts. This will carry his tests up to the brightness level of daylight.

This represents the range of change found in looking from indoor surroundings to outdoor brightnesses. It covers the conditions confronting a motorist entering or leaving a tunnel. In addition, it encompasses the situation of an airplane pilot quickly transferring his attention from his instrument panel to the vista outside his cockpit window (and back again).



Economics of ENGINEERED LIGHTING

By L. G. PARKS

Of all the branches of engineering involved in the design and construction of modern buildings, the one which receives the least investigation and analysis is that of illumination. It is the newest and, contrary to popular opinion, probably the least understood branch of engineering. This lack of understanding is not because illumination is difficult to comprehend but for quite the contrary reason—engineers believe it requires so little understanding that many have never bothered to study it. Illuminating engineering is much like any other engineering involved in building design; to the informed engineer it presents no unsolvable problems, but can be painfully embarassing and costly when treated lightly. To meet today's building standards and remain competitive, the engineer cannot afford to be poorly informed concerning the characteristics of a properly designed, economical lighting installation.

The boom in office building construction during the past decade has been accompanied by a new awareness on the part of the building owners of the need for, and the value of, modern lighting to enhance the interior appearance as well as provide the level of illumination required for the visual tasks to be accomplished. In the modern office building, and many industrial buildings as well, lighting has become a part of the interior decoration, and luminaire design has been developed to complement the architectural features of the interior. With this the lighting engineer can have no argument. On the contrary, he is happy to have lighting received as an attractive part of the over-all design.

The building owner is, of course, interested in low initial cost and to achieve this he is faced with the necessity of reducing costs in whatever area he can. One area that seems to yield cost reductions is that of the interior lighting. A reduction in the installed cost of the luminaire appears to effect a reduction in over-all cost. However, the dangers inherent in this thinking are serious and may prove to be very costly. To emphasize this point the following general statement may be made. When luminaire costs are reduced beyond a determinable point for a given level of illumination, the building costs actually begin to increase, usually without the owner's knowledge.

How is this apparent paradox possible and why is it not recognized as an insidious draining of an owner's capital without value received? The answer can be summed up in a single statement. To most owners a luminaire is a luminaire. Actually, it is not that simple. There is a great range in performance among apparently "equal" luminaires. Consider the popular two- by four-foot, four-lamp recessed troffer presently in wide use in office buildings. This luminaire is available in a multiplicity of depths, lamp and ballast arrangements and light control media. In fact the only non-variables in its construction are its two-foot width and four-foot length. As might be supposed, the luminaire cost also varies widely. Generally speaking, a reduction in luminaire cost is accompanied by a compromise in the desirable characteristics of the luminaire. This compromise usually is a reduction in the efficiency and coefficients of utilization of a luminaire, and an increase in its brightness. An owner concerned with initial cost of a luminaire is perhaps unaware of the effect of this compromise or underestimates its effect on costs.

Substance of an article published in June 1961 issue of *Consulting Engineer*. AUTHOR: Ebasco Services Inc., New York, N. Y.

To an informed engineer these effects are important and the dollar value is very real. If at all possible, he should present the owner with an engineering recommendation covering the building standard luminaire.

Engineers often claim that the building owner dictates the base of design and certain of its components. The engineer may not be asked for his opinion and many times the owner has selected the luminaire before consulting the engineer on details of design. Without question this is true and is the owner's prerogative. However, if the engineer accepts these restrictions without question he becomes a party to them. It is the duty of a consulting engineer to point out the economic facts and the owner will make his decision.

When the owner proceeds on his own initiative in selection of a luminaire he does so for reasons which may include one or more of the following:

- An unawareness of the potential costs involved in "low cost" luminaires.
- A lack of appreciation of the benefits to be derived from quality luminaires.
- The conviction that by shopping through his own contacts and channels he can secure rock-bottom luminaire prices.
- Architectural considerations such as appearance, modular conformity or artistic harmony.
- Reciprocity.

Consider these reasons individually to determine their validity. The first two are entirely negative in aspect and are errors of omission rather than commission. Surely no owner would proceed without engineering advice if he were knowledgeable in these two aspects.

The owner's endeavors to secure rock-bottom luminaire price may bring about his own undoing. Manufacturers' claims seldom admit a competitor's superiority and these claims cannot be checked or verified unless they are based on reports of a recognized photometric testing laboratory. Therefore, to assure himself that claims are valid, the owner should insist on obtaining laboratory reports of any luminaire of which he is considering a volume purchase. Prompt availability of such reports usually is an indication of good faith on the part of the manufacturer.

When the laboratory reports are secured they should be turned over to the engineer for study. A great deal of information is included in a two-page report but a trained engineer is required for translation. After study of the report on a luminaire the engineer is prepared to give the owner the following information:

- Efficiency of the luminaire—the percentage of lamp lumens emitted from the luminaire.
- Brightness of the luminaire at various viewing angles and how these compare with standards of quality of lighting.
- Coefficients of utilization of the luminaire—effects of space dimensions and finishes on light received on the desk top.

If, in addition to the laboratory report, the engineer is given the luminaire price, he can analyze the building lighting costs and recommend action based on these four considerations.

In addition to the laboratory report, physical inspection of the luminaire will be rewarding in determining gage of metal, type of auxiliaries and components, mounting method, general construction and quality of finish.

Architectural considerations of appearance, modular conformity and artistic harmony have become increasingly important and must be reckoned with. Certainly no responsible engineer will argue with an architect regarding appearance or artistic harmony. However, modular conformity is a different story. If to satisfy a peculiar module a special luminaire must be designed, lighting costs will no doubt increase. It is the engineer's duty to point out this increase and why it exists. The decision, as always, is the owner's.

On the question of reciprocity, the engineer can have no opinion. This is the owner's private business. He possesses the facts and the decision is his on whatever basis he chooses to make it.

Engineered lighting begins with luminaire selection and in no case can be considered only the application phase of a pre-selected luminaire. The great benefits of engineered lighting are a result of proper luminaire selection. Here the economics of the installation as well as the quality (brightness control) of the final installation are established. The mechanical application of the luminaire to a physical layout, while time consuming, is of secondary importance.

If, because of his basic restrictions upon his engineer, the owner incurs costs which are unnecessary, the owner has himself to blame. However, the engineer must assume part of the onus because engineering includes the responsibility to advise the client on all areas of design.

Good engineering presupposes a thorough knowledge of all aspects of building design. The owner has the right to refuse the engineer's recommendations but no engineer has the right to withhold any recommendation which, in his opinion, will benefit the owner. The question is this: *Is the owner interested in low cost engineering or an economical building?* Obviously the latter is the prime interest, since engineering cost is part of the building cost.

A luminaire selected on other than a lighting

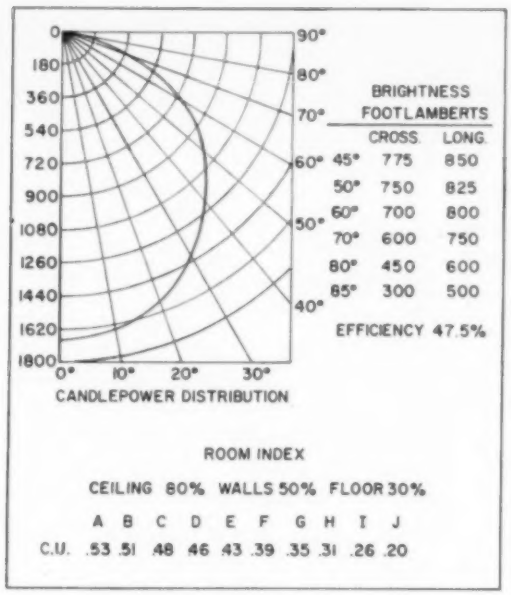


Figure 1.

engineering basis, in most cases, will compromise any later engineering, and if this is not understood, an engineer may be blamed for poor performance of an installation which was beyond his control.

The intense competition among luminaire manufacturers together with very sharp bargaining on the part of building owners has had mixed results in the lighting field. Our economy is based on competition and we cannot decry it. However, there exists in the lighting industry today an unhealthy competition. Prices have been driven down and down and the end product has suffered from the quality standpoint. It is possible to buy superficially similar luminaires over a wide price range—as much as two to one. Here the buyer must be wary, for materials, workmanship and design will vary widely. Claims should be checked through laboratory reports.

Now let us consider some actual luminaire applications and see what the previous discussion actually means in dollars. For purposes of this discussion let us assume an office building of 1,000,000 rentable square feet and 36 stories in height. Setback construction is such that the first 15 floors represent half of the rentable space. For this discussion, the building is to have a minimum maintained level of illumination of 50 footcandles in the rentable space, to be provided by a building standard recessed fluorescent fixture.

In order to simplify and reduce the number of calculations we shall assume an average room index of F (1.5) and the following reflectances: ceilings, 80 per cent; walls, 50 per cent; floors, 30 per cent. Further, we shall assume 480/277-volt service provided by two transformer banks, one located in the basement and serving the first 15 floors, the other located at the 24th floor and serving floors 16 to 36. 416/240-volt service would produce similar results.

Similarly assume two air-conditioning compressor installations located on the same floors as the transformer banks and serving the same floors.

All luminaires used in this analysis are standard catalog items.

Case I

The building owner has selected a building standard luminaire. The distribution curve, brightness data and coefficient of utilization of this luminaire are shown in Fig. 1. These data have been verified by a recognized photometric testing laboratory. The luminaire is a two- by four-foot, four-lamp, rapid-start unit with a formed, one-piece, thin plastic diffuser, fully recessed and costing $30.

The engineers prepare a preliminary lighting design to determine the total number of luminaires required and the electrical load involved. They also determine the installed cost of lighting and annual energy and maintenance costs. These computations follow:

Total number of luminaires required

$$A = \frac{E \times R}{B \times L \times CU \times MF}$$

where

E = Illumination in footcandles
R = Rentable square feet
B = Number of lamps per fixture
L = Light output per lamp in lumens
CU = Average coefficient of utilization (F = .39)
MF = Maintenance factor (.70)

$$A = \frac{50 \times 1{,}000{,}000}{4 \times 2800 \times .39 \times .70}$$

= 16,383 luminaires
= 1 luminaire per 61 square feet

Lighting costs are:

Cost of luminaires:	$16{,}383 \times \$30$	= $491,490
Luminaire installation:	$16{,}383 \times \$16$	= 262,128
Luminaire outlets (3 Luminaires/outlet):	$\frac{16{,}383 \times \$22}{3}$	= 120,142
Lamp cost:	$16{,}383 \times 4 \times .90$	= 58,979
Total installed lighting cost		= $932,739

Lighting Electrical Load

$$= \frac{16{,}383 \times 180 \text{ (w/luminaire)}}{1000}$$

= 2949 kw
= 2.95 watts per square foot

Lighting Air Conditioning Load

$$= \frac{2949}{3.51 \text{ (kw/ton of refrigeration)}}$$

= 840 tons of refrigeration

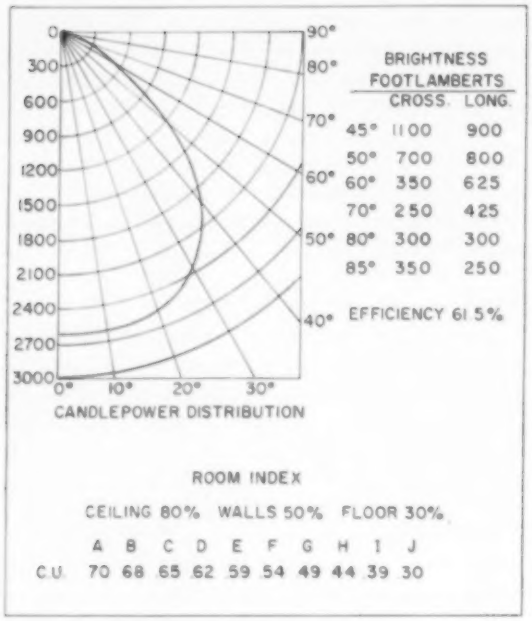


Figure 2.

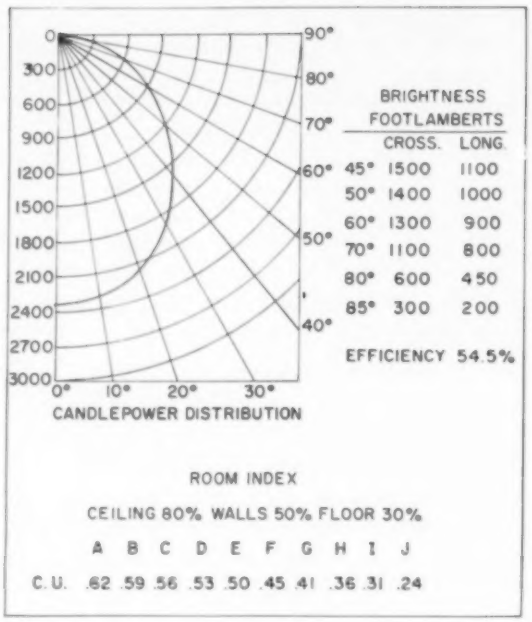


Figure 3.

Cost of Air Conditioning
for lighting = 840 × $1000 = $840,000
Lighting Electrical Service Costs,
Estimated—$62,100
Air Conditioning Electrical Service Costs,
Estimated—$12,900
Annual Lighting Electrical Energy Cost
Energy charge
2949 × 3120 (Burning hours per year)
= 9,200,880 kwh
9,200,880 × 1.15¢ (Energy charge/kwh)
= $105,810
Demand Charge
2949 × $1.60 (Demand charge/month)
× 12 = 56,621
Total = $162,431
Annual Air Conditioning Electrical Energy Cost
Energy Charge
840 × 1000 (operating hours/year)
= 840,000 kwh
840,000 × 1.15¢ (Energy charge/kwh)
= $ 9660
Demand Charge
840 × $1.60 (Demand charge/month)
× 5 (months operation/year) = 6720
Total = $16,380
Annual Maintenance Cost
Luminaires × Lamps/Luminaire
× Rate/month/lamp × months/year
16,383 × 4 × $0.15 × 12 = $117,958
These data are shown in column 1, Table I

Case II

The building owner left selection of the luminaire entirely to the engineer. The engineer after investigation recommends a two- by four-foot, four-lamp, rapid-start luminaire with a low brightness glass lens mounted in a hinged door. The luminaire is fully recessed and its cost is $45. Photometric data

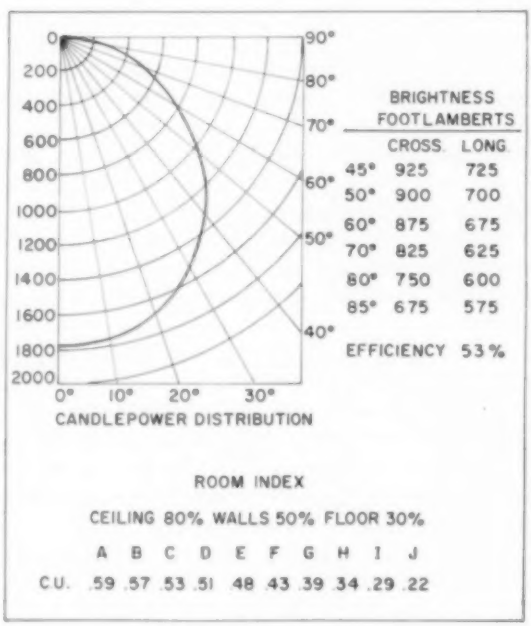


Figure 4.

Table I

BASIC DATA	CASE I FIG. 1	CASE II FIG. 2	CASE III FIG. 3	CASE IV FIG. 4
1. Rated lumens per luminaire	11,200	11,200	11,200	11,200
2. Lamp life (hours)	7500	7500	7500	7500
3. Watts per lamp	40	40	40	40
4. Watts per luminaire (including ballast)	180	180	180	180
5. Efficiency	47.5%	61.5%	54.5%	53%
6. Coefficient of Utilization (Assume F average)	.39	.54	.45	.43
7. Maintenance factor	.70	.70	.70	.70
8. Luminaire cost	$30	$45	$40	$37
9. Number of luminaires required	16,383	11,810	14,148	14,830
9a. Square feet per luminaire	61	85	71	68
10. Total luminaire cost	$ 491,490	$ 531,450	$ 565,920	$ 548,710
11. Luminaire installation cost	$ 262,128	$ 188,960	$ 226,368	$ 237,280
12. Outlet installation cost	$ 120,142	$ 86,614	$ 103,752	$ 108,768
13. Lamp cost	$ 58,979	$ 42,516	$ 50,933	$ 53,388
14. Total installed luminaire cost	$ 932,739	$ 849,540	$ 946,963	$ 948,146
14a. Installed cost difference from Case I		−$ 83,199	+$ 14,224	+$ 15,407
15. Lighting—watts/square foot	2.95	2.13	2.55	2.67
16. Lighting electrical load—kw	2949	2126	2547	2669
17. Lighting air conditioning load—tons of refrigeration	840	606	726	760
18. Lighting air conditioning—cost	$ 840,000	$ 606,000	$ 726,000	$ 760,000
19. Electrical service costs—lighting	$ 62,100	$ 43,500	$ 53,000	$ 55,900
20. Electrical service costs—air conditioning	$ 12,900	$ 9,100	$ 11,100	$ 11,600
21. Total installed cost (Items 14, 18, 19, 20)	$1,847,739	$1,508,140	$1,737,063	$1,775,646
21a. Total installed cost savings over Case I		$ 339,599	$ 110,676	$ 72,093
22. Lighting electrical energy cost/year	$ 162,431	$ 117,100	$ 140,288	$ 147,009
23. Annual maintenance cost	$ 117,958	$ 85,032	$ 101,866	$ 106,776
24. Electrical energy cost—air conditioning assuming 1000 hours per year operation over 5-month period	$ 16,380	$ 11,817	$ 14,157	$ 14,820
25. Annual owning cost of lighting system—15 per cent of Items 10, 11, 12	$ 131,064	$ 121,054	$ 134,406	$ 134,214
26. Annual owning cost of air conditioning system for lighting—10 per cent of Item 18	$ 84,000	$ 60,600	$ 72,600	$ 76,000
27. Annual owning cost of electrical service for lighting—10 per cent of Item 19	$ 6,210	$ 4,350	$ 5,300	$ 5,590
28. Annual owning cost of electrical service for air conditioning—10 per cent of Item 20	$ 1,290	$ 910	$ 1,110	$ 1,160
29. Total annual cost of lighting system—Items 22, 23, 24, 25, 26, 27, 28	$ 519,333	$ 400,863	$ 469,727	$ 485,569
30. Total annual savings over Case I		$ 118,470	$ 49,606	$ 33,764

of this luminaire are shown in Fig. 2. The engineer is asked to develop the same data as in Case I. These data are shown in column 2, Table I.

Case III

The building owner is delighted with the cost information developed in Case II but he has a connection with a lighting manufacturer who advises that he can furnish substantially the same luminaire for $40. The owner is very interested in this additional saving and asks his engineer to study the luminaire. The engineer examines a sample luminaire and finds it similar to the fixture recommended. He secures photometric data from the manufacturer who has had his fixture tested by a photometric testing laboratory. These data are shown in Fig. 3. Data developed by the engineer are shown in column 3, Table I.

Case IV

The building owner is attempting to reduce cavity space to a minimum and specifies a very shallow luminaire. It is a two- by four-foot, four-lamp, rapid-start unit with formed, thin plastic diffuser extending somewhat below the ceiling. Its cost is $37 and its photometric data are shown in Fig. 4. Data developed by the engineer are shown in column 4, Table I.

An analysis of the costs shown in Table I reveals results which are startling to the uninformed. Several conclusions may be drawn from these data. Since Cases I and II represent the extremes in this

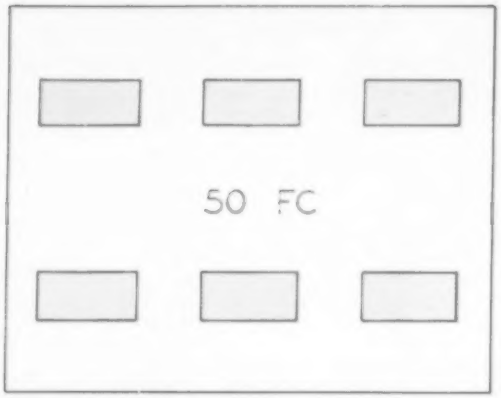


Figure 5. Room 16 by 20 feet, R.I. = 1.5, Luminaire I.

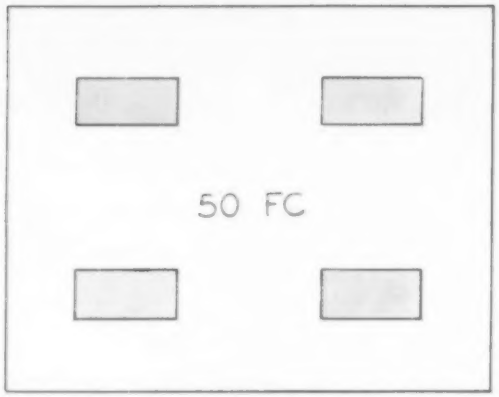


Figure 6. Room 16 by 20 feet, R.I. = 1.5, Luminaire II.

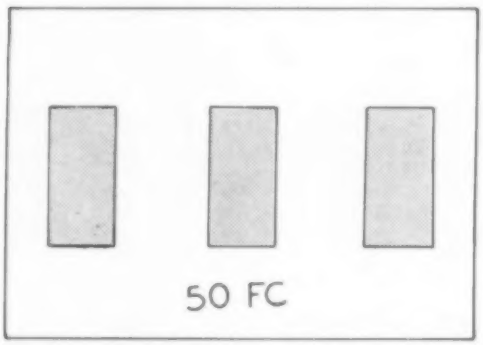


Figure 7. Room 10 by 14 feet, R.I. = 1.0, Luminaire I.

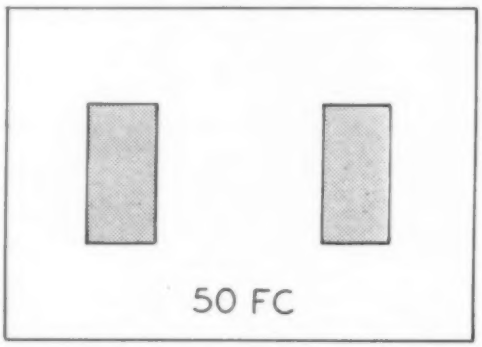


Figure 8. Room 10 by 14 feet, R.I. = 1.0, Luminaire II.

situation only these two will be discussed in detail.

(1) Initial cost of the luminaire is of little importance. It may vary within wide limits. A high initial cost accompanied by a high coefficient of utilization may prove quite economical. If the $45 luminaire of Case II had been priced at $52 the total installed luminaire cost would still have been less than that of the $30 luminaire of Case I. The difference in C.U. in Cases I and II is 15 percentage points. The total installed luminaire saving is $83,199 or $5547 per percentage point.

(2) On an annual cost basis, initial luminaire cost becomes almost unimportant. The annual savings of Case II over Case I is $118,470. Since the only variable being considered is the luminaire cost, this annual savings represents an installed luminaire cost differential of $789,800. Since number of luminaires, outlets and lamps remain constant this total amount may be charged against luminaire cost. This equals $67 per luminaire. Therefore, the building owner could have paid $112 for the luminaire in Case II without exceeding the annual costs of Case I. This represents a 267 per cent price increase over the basic $30 figure. This may be stated perhaps more dramatically. If the luminaire of Case I had been given to the building owner free of charge, his lighting system would still cost $44,746 more annually than if he had purchased the luminaires of Case II at $45 each.

(3) Savings in installed air conditioning costs are of great significance when more efficient luminaires are employed. This dividend should be carefully considered and developed during engineering design of a building.

(4) Energy costs and maintenance costs vary as the number of luminaires. Substantial savings can be secured with high efficiency luminaires.

(5) Figs. 5 to 10 reveal the advantages of Case II over Case I in three typical rooms. Note that reduction in number of luminaires also improves the ceiling appearance of the room.

(6) An analysis of the photometric data in Figs. 1, 2, and 4 indicates that the low brightness lens of Case II is, in fact, low brightness. The brightness in the viewing angles above 45 degrees is lower than that in Cases I and IV, thus providing more seeing

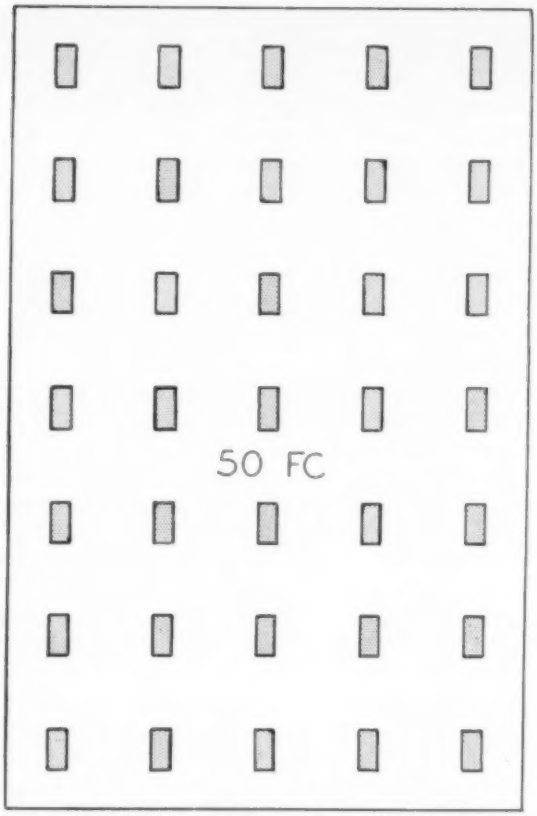


Figure 9. Room 50 by 75 feet, R.I. = 5.0, Luminaire I.

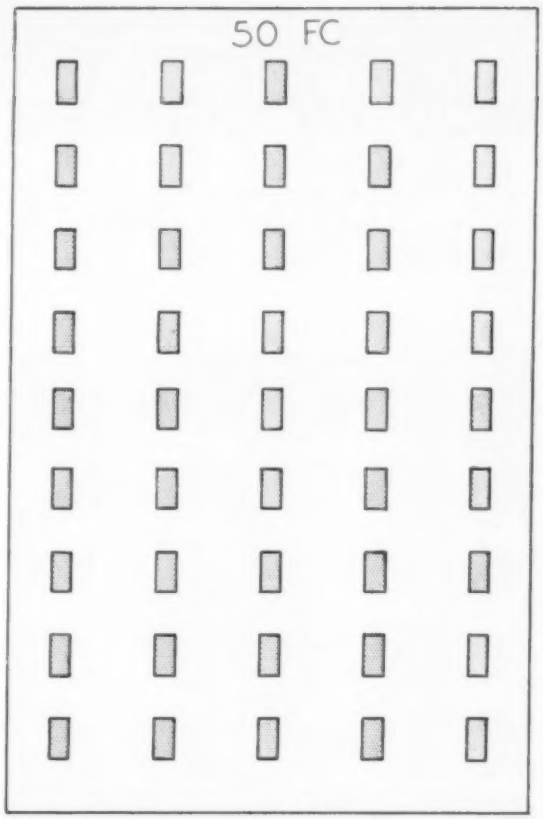


Figure 10. Room 50 by 75 feet, R.I. = 5.0, Luminaire II.

comfort (higher quality) in the area and, at the same time, directing more illumination to the working plane, thus securing greater light utilization.

(7) The photometric data of Fig. 3 indicate that the substitute luminaire of Case III has been improperly designed from a quality standpoint. The lens characteristics have been greatly altered as indicated by the very high brightness above 45 degrees, resulting in a reduction in utilization of light and greatly reduced seeing comfort. This substitution would result in a substantial increase in both initial and annual costs over Case II.

(8) Contrary to prevailing opinion, increased quality of illumination need not result in increased lighting costs. In Case II quality has been substantially improved over Case I and lighting costs have been considerably reduced.

(9) The foregoing comparison of luminaires has been based on equal levels of illumination, *i.e.*, 50 footcandles. In item (6) above it was pointed out that Case II provides a higher degree of visual comfort than any of the others. It is a well established axiom of illuminating engineering that as luminaire brightness increases in the viewing angles above 45 degrees, the effective illumination on the working plane (in office applications) decreases. The net result is that a higher illumination must be provided to offset, to some degree, the visual discomfort caused by luminaire brightness. Therefore, the situation presented for Cases I, III and IV is optimum. In reality the effective illumination is less than in Case II.

It should be borne in mind that the foregoing statistics apply only to the luminaires described. However, the study method and discussion are universally true and can be used in any situation involving luminaire selection. The results of such a study are well worth the time and money involved. The selection of the lighting luminaire has been made for reasons of economy and quality which have been developed by engineering investigation. The resulting lighting design is a credit to the engineer and a dividend to the owner. More than this, it produces a highly acceptable working environment which, after all, is the prime purpose of the installation.

MODERN LIGHTING BOOSTS SALES

BETWEEN THE glamorous store lighting installation designed on an expandable budget and the dreary five footcandles from glaring, ancient incandescent units lie a variety of lighting techniques, capable of providing the retailer with an extra "front-line" salesman. Within a wide range of budgets, store lighting can be designed to fulfill two basic objectives—provide a pleasant, attractive environment and enhance the appearance of the merchandise. Further refinements for added sales appeal are dependent, of course, on the amount of money which is available for decorative lighting treatment.

Before: **Obsolete incandescent lighting at Cannon Tailors.**

RAISING THE LEVELS

Primary objective in any store lighting design is to assure an adequate level of general illumination for appraisal of merchandise and pleasantness of environment. For relighting in older stores on limited budgets, today's fluorescent sources (particularly the extra-high-output lamps) can provide an adequate level of light for minimum capital and operational costs. In the two relighting designs shown here, for a men's clothing store and a rug and upholstery area of a department store, obsolete, low-level incandescent systems replaced with 1500-ma fluorescent installations brought immediate results in increased sales receipts.

At Cannon Tailors in Cleveland, relighting was confined to the installation of new equipment, with no provisions in the budget for improvement of surface reflectances. The new lighting design involved a row of eight-foot, 1500-ma units, mounted

After: **Diffuse general illumination from 1500-ma fluorescent system provides customer and employee comfort.**

in pairs, on nine-foot, seven-inch centers over each of the sales areas. Deluxe cool white lamps, providing good color rendition of fabrics and skin tones, are used to create a psychologically favorable selling environment. The ten-foot fixture mounting height serves the architectural aim of lowering the apparent ceiling height at no extra cost.

In the home furnishings department of the Carlisle-Allen Department Store in Ashtabula, Ohio, a 50- by 120-foot multi-sales area with a 12½-foot ceiling, the ten-footcandle lighting level produced by suspended incandescent fixtures has been replaced by an average general illumination level of 120 footcandles with the installation of extra-high-output fluorescent units. Forty-six eight-foot, two-lamp and five four-foot, two-lamp louvered fixtures are arranged on ten-foot centers in the central sales area and evenly spaced over the side aisles. Fixtures are mounted at 11 feet to avoid the multitude of ceiling obstructions and eliminate the expense required for the installation of a dropped ceiling.

ADDITION OF HIGHLIGHTING

Against the background of diffuse, high-level general illumination from the fluorescent system, 300 footcandles of highlighting are directed at a feature display located at the entrance to the furniture department. This is provided by five 200-watt PAR46 eyeball spots mounted between the fluorescent units.

Despite the fact that the cluttered ceiling still detracts somewhat from the general appearance of the store, the revamped lighting system is paying

In the endless variety of store lighting designs is an installation to please any pocket. From the simple change to higher levels to the use of lighting as an advertising technique, proper illumination is a valuable merchandising aid.

Highlighting adds sales appeal to feature display.

Before: **Low-level lighting creates unattractive sales environment at Carlisle-Allen Department Store.**
After: **(right) General lighting levels of 150 footcandles brighten customers' moods and sales receipts.**

Incandescent highlighting for sparkle on jewelry displays, valance over wall cases and general lighting levels of 180 footcandles are combined to provide an attractive background for selling at Ecker's Jevel Box.

dividends. During an unfavorable economic period immediately following installation of the lighting, sales in this luxury product department increased noticeably and have continued steadily on this upward trend.

A more extensive application of highlighting, to draw attention to merchandise and provide a change of pace in lighting environment through emphasis on texture, color and form, is illustrated in the lighting of Ecker's Jewel Box, Winston-Salem, N. C. Here, merchandise in the showcases sparkles under incandescent highlighting and a valance provides illumination on the vertical surfaces of the wall cases. The row of 300-watt incandescent units recessed over the showcases provides 200 footcandles of localized lighting on the counter tops. Placement of these fixtures so that their centerlines are approximately ten inches from the centerline of the counter on the customer's side, directs a maximum amount of light at the point of merchandise appraisal and minimizes veiling reflections in the customer's field of view. Additional highlighting (240 footcandles) for a wrapping counter at the rear of the store is provided by three 300-watt incandescent units.

General illumination system in the store is a luminous element extended through the center of the 34- by 19-foot sales area. Four extra-high-output cool white fluorescent lamps are mounted above 16 two- by two-inch lenses in the ten-foot ceiling for an average general lighting level of 180 footcandles. Surface reflectances of walls, 50 per cent; floor, 35 per cent and ceiling, 75 per cent assure a comfortable visual environment.

For continuity of lighting design between the sales area and exterior show windows, a combination of extra-high-output fluorescent lamps shielded by two- by two-foot lenses and recessed 300-watt incandescent fixtures is used in the windows. These are alternately spaced to provide an illumination level of 350 footcandles with sparkle on the jewelry displays.

ESTHETIC REFINEMENT

While esthetic judgment is largely a question of individual taste, the general preference for the streamlined over the cluttered look is hardly debatable. Particularly in a department store, where the environment has a considerable effect on customer's willingness to purchase, an attractive environment is a valuable asset.

At Belk's Department Store in Columbia, S. C.,

Before: **Appearance of suspended fluorescent fixtures in old section of Belk's Department Store compares unfavorably with recessed units in modern addition (right).**

the contrast between the rows of large-area recessed fixtures and orderly ceiling of a new four-story addition and the suspended fixtures and busy ceiling of the older part of the store (see photos) only served to date the older lighting system. However, since the suspended fixtures represented a fairly recent expenditure of $25,000 and provided an adequate illumination level, they were not to be discarded for new lighting equipment. The economical solution to this problem was to create the effect of recessed lighting in the older area by the installation of ceiling panels.

Coincidentally, the fixture louvers were similar in size to the sections of ceiling channel, and with their edges clipped and centers notched could lie perfectly in the channels. Extra supports for the panels were installed to hold the weight of the fixtures which were placed on top of the louvers. Top-plate reflectors were added to minimize the loss of uplight from the formerly direct-indirect units. Maintenance is accomplished by removing sections of ceiling adjacent to the fixtures; wiring with flexible conduit from existing outlets minimized remodeling costs and provides for future rearrangement of the lighting.

GLAMOR LIGHTING

The dramatic lighting effect, used as an advertising technique, is an almost mandatory component of effective store lighting in highly competitive sales areas. For established businesses losing customers to modern shopping centers, remodeling and relighting are often the key to survival. Lighting for these stores must not only meet illumination requirements but, as a decorative element, add to the distinctiveness of the architectural design.

Economical remodeling of suspended fixtures through installation of ceiling panels turns them into "recessed" units. Attendant elimination of cluttered ceiling greatly improves general appearance of store.

Pleasing appearance of rows of large area recessed fixtures in four-story annex to Belk's Department Store spurred remodeling of older suspended lighting system. Now modern look of recessed lighting in both sections (see photo above) creates continuity of appearance.

Dramatic lighting integrated with architecture of this open-front store was designed to win customers back from competitors in modern shopping centers. Luminous element extended two feet beyond glass front and over drive-in sales area gives an illusion of greater size to the store.

The open front store, designed to place the entire interior on view to passing shoppers is one of the most popular modern architectural devices. Reinforcing the effect of the open front in the bakery pictured above is the sloping luminous ceiling, extended through the sales area to the exterior to enlarge the apparent size of the store. The slope of the ceiling was designed to place a larger luminous area in the field of view (for an illusion of size) and draw attention to merchandise on the back-wall shelves.

Since the old ceiling in the bakery was already overloaded and unable to support any additional weight, a self-supporting luminous ceiling system was required. The framework is constructed of sloping two- by six-inch beams installed on two-foot centers and extended two feet beyond the front wall with outriggers attached to the ends to form the marquee. Over the drive-in area, two- by twelve-inch beams were used. A yoke system which provides exact centering of the lighting units below the beams and keeps lamps parallel to the ceiling is used to mount the lighting channels to the framework. Over the drive-in sales area at left, lighting channels are mounted directly to the roofing through a piece of preformed fiber insulation. Beams, yokes and cavities are painted white for maximum reflection of light into the sales area.

Plexiglas diffusing panels are attached to the bottom of the beams with four-inch wide wooden strips which match the panelling in the rest of the store and provide a relief from the brightness of the luminous element. The inherently specular Plexiglas was sand blasted to produce a diffuse surface and eliminate hot spots in the plastic and reflections from the showcases.

Lighting arrangement in the sales area consists of three continuous rows of three single-lamp four-foot rapid-start fluorescent channels mounted in each beam opening. These provide a level of 100 footcandles at counter height. A continuous row of four-foot rapid-start lamps is installed behind the facade. Facade lighting was designed for lower brightness than the rest of the ceiling because at normal viewing angles it is silhouetted against black surroundings, resulting in an apparent increase in its brightness.

The lighting is divided into three sections, each controlled by a dimmer for flexibility of illumination levels and security after business hours. The plenum is ventilated through the old ceiling for cool operation of the lamps. Localized fluorescent lighting over the rear shelves and in the drive-in counter was designed to permit quick customer appraisal of the merchandise.

CREDITS

All installations shown in this article were entries in the 1961 Applied Lighting Competition at the Section level. Lighting designers were: *Cannon Tailors*, William M. Bush, Cleveland Electric Illuminating Co., Cleveland Section; *Carlisle-Allen Department Store*, Fred R. Frisbie, The Illuminating Co., Ashtabula, Ohio, Cleveland Section; *Ecker's Jewel Box*, George S. Parrish, Duke Power Co., Winston-Salem, N. C., Tar Heel Section; *Belk's Department Store*, E. M. Williams, Cashion Electricians, Inc., Columbia, S. C., Palmetto Section; *Reussow's Bakery*, John E. Loos, Niagara Mohawk Power Corp., Syracuse, N. Y., Central New York Section.

INSTALLATION AT
ALUMINUM CASTING AND
ENGINEERING CO.
2039 S. LENOX ST.
MILWAUKEE, WIS.

Industrial Lighting

LIGHTING OBJECTIVE: To provide general illumination in a high-bay and low-bay area for the manufacture and examination of aluminum casings and castings.

GENERAL INFORMATION: Aluminum castings are produced and examined for flaws in the area shown above. This area measures approximately 15,000 square feet. Ceiling heights are 14 feet in the low-bay portion and 24 to 27 feet in the gable-roof high-bay portions. Colors and reflectances of the major surfaces of this permanent mold foundry are: ceiling, grey (50% RF); walls, grey concrete block (30% RF); and floor, grey concrete (40% RF).

INSTALLATION: Abolite Lighting catalog No. HMFAU 1800 luminaires, mounted in pairs on 11-foot by 13-foot centers, 13 feet above the floor, provided an average level of 225 footcandles in the low-bay area after three months' operation. Each unit, which has an 18-inch diameter Alzak aluminum reflector, is equipped with one H1LK 400-watt improved-color mercury lamp.

Also after three months' operation, Abolite Lighting catalog No. HMFAU 2400 luminaires, mounted singly on approximately 12-foot by 15-foot centers at about 25 feet above the floor, provided an average level of 180 footcandles in the high-bay area. Each of these units, which has a 24-inch diameter Alzak aluminum reflector and provisions for an 18 per cent upward light component, is equipped with one H12KY 1000-watt improved-color one-half phosphor-coated mercury lamp. Brightness readings after three months' operation were:

ceiling, above luminaires	50 fL	floor	35 fL
ceiling, between luminaires	10 fL	luminaire, high bay, 35 degrees	3000 fL
walls	20 fL	45 degrees	14000 fL

Lighting designed by James Lutz, Trester Engineering Co., Milwaukee, Wis. Electrical contractor was Bentley-Jost Electric, Milwaukee, Wis.

Lighting data submitted by Jim Augustine, Electric Supply Corp. of Wisconsin and Richard Garber, Wisconsin Electric Power Co. both of Milwaukee, Wis., as an illustration of good lighting practice and to aid in the design of similar installations.

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FOG ON RUNWAYS

By DOMINA EBERLE SPENCER

THIS PAPER studies the effect of fog on illuminated runways. Long, low strips of fluorescent luminaires[1] flood the entire runway with a rectangular pancake of light; yet the pilot is completely shielded from direct glare. The appearance of a runway surface as viewed by the pilot in clear weather is shown in Fig. 1. How effectively will the runway be lighted in fog? This paper is devoted to an attempt to answer this question.

The effect of fog on the strip-lighted runway is threefold:

(1) The fog between luminaire and runway surface modifies the incident light;

(2) The entire layer of fog between pilot and runway attenuates the light reflected from the pavement;

(3) The thin, rectangular pancake of illuminated fog close to the runway reduces contrast of surface details.

Calculations are described which permit each of these effects to be quantitatively evaluated in any type of fog.

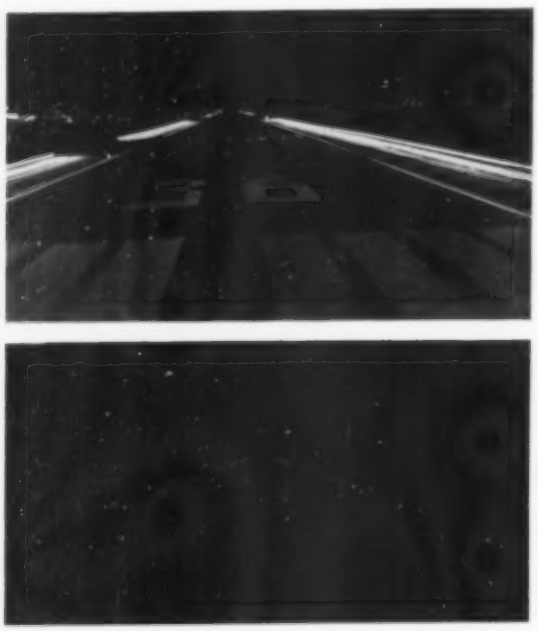

Figure 1. Pilot's view of approach to Washington National Airport with low-mounted, controlled fluorescent luminaires as compared with the traditional "black hole."

Runway Configurations

In this paper, two configurations of luminaires are studied. These are shown in Fig. 2. The first example is for a runway 45.7 meters (150 feet) wide and 914 meters (3000 feet) long. In the second, the runway is wider and shorter, being 61.0 meters (200 feet) wide and 396 meters (1300 feet) long. The second example corresponds to a slight simplification of the arrangement in Fig. 1.

The reflector contour and shielding shown in Fig. 3 combine to send no light above a theoretical cutoff plane which is approximately horizontal. Luminaires may be tilted slightly below horizontal if desired. In order to provide clearance for propeller blades, the tops of the luminaires were required to be no more than 0.724 meters (28.5 inches) above the runway surface.

Theoretically, at the center of the runway, for any point below the cutoff plane the entire reflector appears to be filled with an image of the lamp. Thus, save for the effect of endcaps and window mullions, the strip luminaires may be treated as long thin rectangular sources extending from 0.470 meters (18.5 inches) to 0.724 meters (28.5 inches) above the runway surface. Actually, a small amount of light escapes from the luminaire above the theoretical cutoff plane. This component cannot be entirely eliminated because of stray light and because the reflector is not perfectly specular. The sharpness of the actual cutoff plane for the luminaire has been indicated in previous papers.[1]

Runway Fogs

The range of fogs of importance for the runway problem can be specified by the following values of the attenuation coefficient:

Light runway fog, $\alpha = 3.28 \times 10^{-3}\ m^{-1} = 10^{-3}\ ft^{-1}$,

Moderate runway fog, $\alpha = 1.640 \times 10^{-2}\ m^{-1} = 5 \times 10^{-3}\ ft^{-1}$,

Thick runway fog, $\alpha = 3.28 \times 10^{-2}\ m^{-1} = 10^{-2}\ ft^{-1}$.

These correspond to meteorological visual ranges in daylight of 916 meters, 183 meters and 91.6 meters or 3000 feet, 600 feet and 300 feet, respectively. In computing visual ranges, the distance corresponding to a transmittance of 0.05 has been cal-

AUTHOR: University of Connecticut, Storrs, Conn.

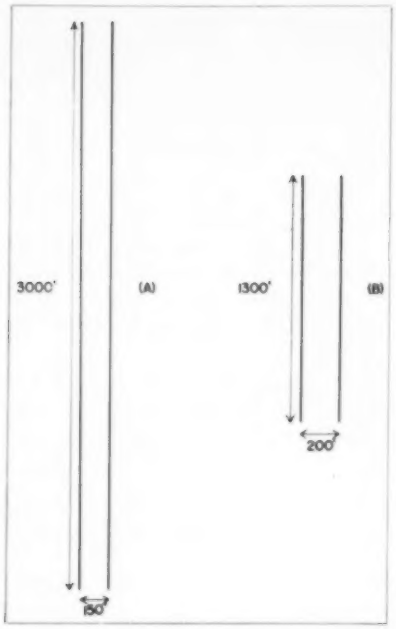

Figure 2. Two runway configurations.

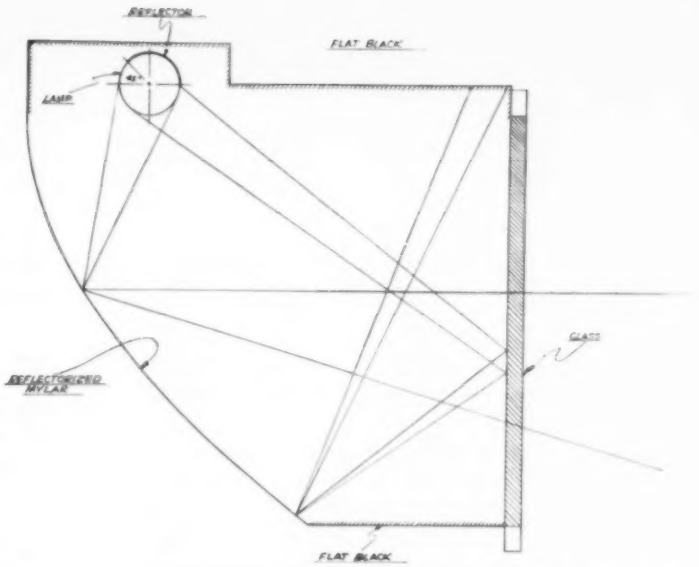

Figure 3. Cross section of fluorescent luminaires shown in Fig. 1. The reflector is a macrofocal parabola. All direct light from the lamp is reflected below a horizontal cutoff plane.

culated. In accordance with the conclusions of a previous paper,[2] a single shape of scattering coefficient is used for the entire range of runway fogs.

Luminaire as Viewed from Center of Runway

In this paper, it will be assumed that the helios (brightness if expressed in terms of a lightcone converging at the observer) of the luminaire, as viewed below the cutoff plane in clear weather, is a constant H_s. However, in a fog with attenuation coefficient α the light reaching a point P at the center of the runway (Fig. 4) from various parts of the luminaire at various angles β must travel through varying distances l in the fog. Thus, the helios H_{sf} of the luminaire as viewed in a fog at

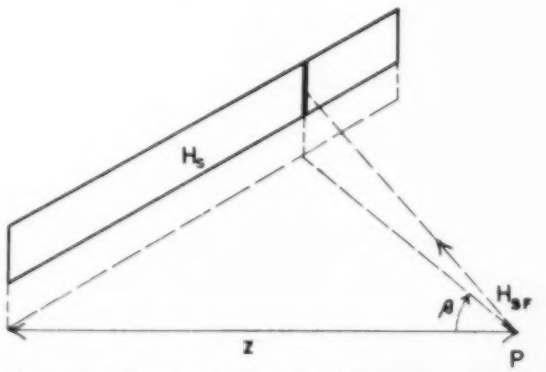

Figure 4. Helios (brightness) H_{sf} of luminaire as viewed from a point P at center of runway in fog.

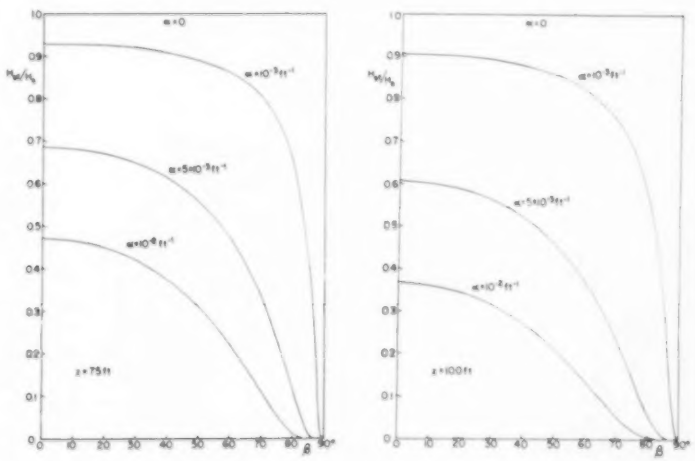

Figure 5. Helios (brightness) H_{sf} of luminaire as viewed from center of each runway configuration vs angle α.

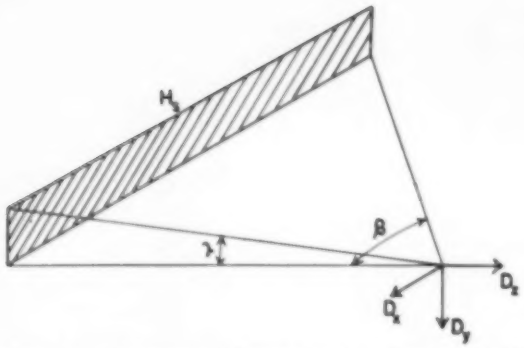

Figure 6. Pharosage (illumination) vector D which specifies incident light from unit at center of runway.

point P depends on the distance z to the center of the runway and on the angle β. From the definition of the attenuation coefficient

$$H_{sf} = H_s\, e^{-\alpha z \sec \beta} \qquad (1)$$

if z is large compared to the luminaire mounting height. Fig. 5 shows values of H_{sf}/H_s versus β for points at the center of each of the runway configurations of Fig. 2.

It will be noted that the fog introduces a natural louvering effect which disappears when the fog lifts. Thus, use of moderate vertical louvers will have negligible effect in dense fogs but will have marked adverse effect in clear weather.

For example, if black endcaps (reflectance zero) are used on eight-foot luminaires, a maximum of seven degrees of louvering results. In Fig. 5 the values of H_{sf} would be reduced to zero between $\beta = 83$ degrees and $\beta = 90$ degrees. But in a dense runway fog, H_{sf} is already negligible beyond 80 degrees, so these louvers would have no appreciable effect except in clear weather. Even if two intermediate louvers are inserted, only 20 degrees of louvering results. In dense fogs the natural louvering has already so reduced the helios (brightness) of the luminaire at large values of β that advantages of moderate louvering are insignificant.

Incident Light at Center of Runway

The incident light on any surface at the center of the runway is specified by the *pharosage* (illumination) *vector* **D**. Knowledge of this vector will permit the prediction of the appearance of any perfectly diffusing runway surface or marking. As the runway surface is crowned and markings may be slightly raised, all three components of this vector will be needed.

The pharosage (illumination) vector will be calculated for a section of the luminaire which subtends the angles β and γ shown in Fig. 6. The component specifying light incident on a horizontal surface is called D_y. The number of lumens per unit area incident on a vertical surface parallel to the luminaire is called D_z, while that on the illuminated side of a vertical surface perpendicular to the luminaire is called D_x.

In runway applications, the angle γ subtended by the top of the luminaire at the center of the runway is so small that $\sin\gamma \approx \gamma$ and $\cos\gamma \approx 1$. The three components[3] of the *illumination vector* **D** for clear weather ($\alpha = 0$) are given by the equations,

$$\begin{cases} D_z = \dfrac{H_s \gamma}{2\pi} \sin^2 \beta, \\ D_y = \dfrac{H_s}{4\pi} \beta\gamma^2, \\ D_x = \dfrac{H_s \gamma}{2\pi} [\beta + \sin \beta \cos \beta]. \end{cases} \qquad (2)$$

In foggy weather, an integration must be performed to take into account the variable bright-

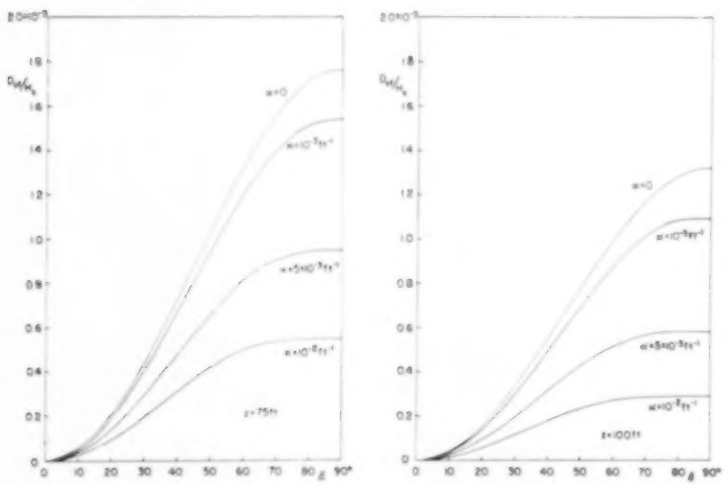

Figure 7. The *x*-component of the *D*-vector at the center of the runway in clear weather and in fog, for the two configurations of Fig. 2.

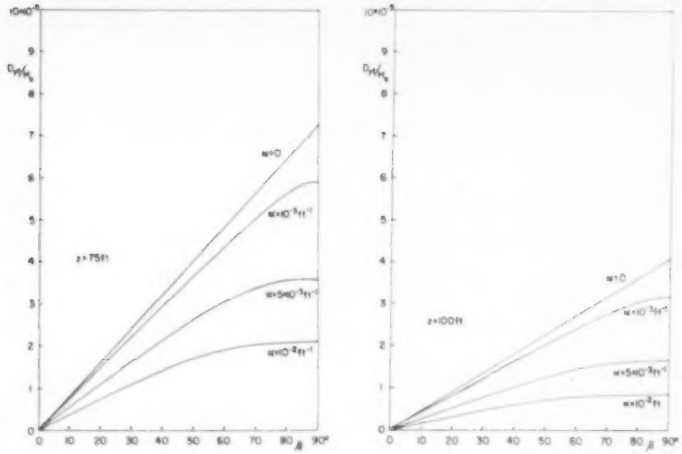

Figure 8. The *y*-component of the *D*-vector at the center of the runway in clear weather and in fog, for the two configurations of Fig. 2.

ness of the source as viewed in the fog. The components of the **D**-vector in fog are

$$\begin{cases} D_{xf} = \dfrac{H_s \gamma}{2\pi} \displaystyle\int_0^\beta \sin 2\beta \; e^{-\alpha z} \sec \beta \; d\beta, \\ D_{yf} = \dfrac{H_s \gamma^2}{4\pi} \displaystyle\int_0^\beta e^{-\alpha z} \sec \beta \; d\beta, \\ D_{zf} = \dfrac{H_s \gamma}{2\pi} \displaystyle\int_0^\beta (1 + \cos 2\beta) e^{-\alpha z} \sec \beta \; d\beta. \end{cases} \tag{3}$$

Values of $\mathbf{D}_f$ were obtained by numerical integration of Equation 3 with a planimeter. The results are shown in Figs. 7, 8 and 9. Superposition of values calculated from Equations 2 and 3 for two different values of γ corresponding to the angles subtended by the top and bottom of the luminaire from the center of the runway was employed.

If the luminaires are adjusted with cutoff plane tilted slightly below horizontal, through a small angle α and the runway surface is tilted toward the luminaire by a small angle δ, the incident illumination on the runway surface is

$$D = D_y + (\alpha + \delta) \; D_z. \tag{4}$$

For example, if the cutoff plane is adjusted 0.75 degree below horizontal and the runway surface at center is horizontal, $D = D_y + (0.01302) \; D_z$. As D_z is of the order of fifty times D_y, the contribution of D_z is of considerable importance even for very small angles of tilt.

Gradients in Fog

The heliosent[2] G is the gradient of the helios (brightness) resulting from scattering of light in the fog. At point P, the incident pharosage (illumination) on the fog from an element of luminaire subtending an angle $d\beta$ (Fig. 10) is

$$dD_o = \frac{H_s h}{\pi z} \cos \beta \; d\beta \; e^{-\alpha z} \sec \beta,$$

where h is the height from top to bottom of the

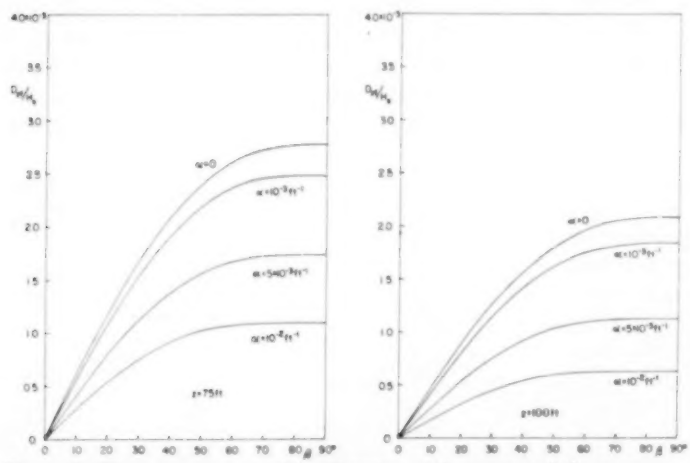

Figure 9. The *z*-component of the *D*-vector at the center of the runway in clear weather and in fog, for the two configurations of Fig. 2.

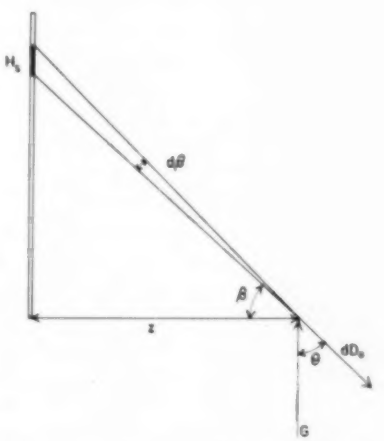

Figure 10. Incident light from luminaire produces heliosent in fog.

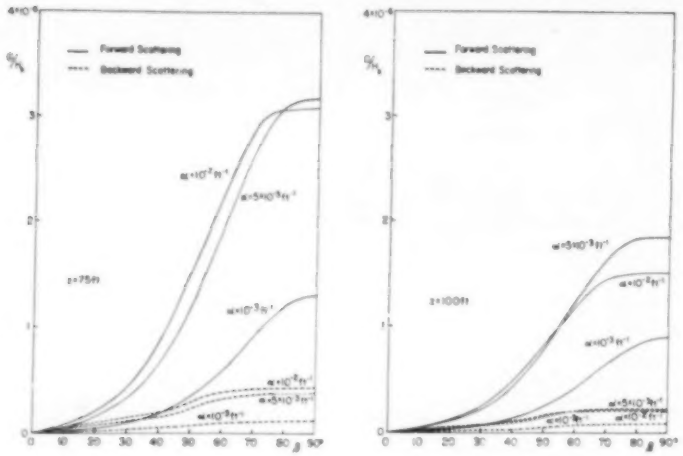

Figure 11. Heliosent in fog produced by forward and backward scattering.

luminaire. Then, from the definition of the scattering coefficient[2] μ (θ), the heliosent resulting from primary scattering from the section of luminaire in front of the observer is

$$G = \frac{H_s h}{\pi z} \int_o^\beta \mu\left(\frac{\pi}{2} - \beta\right) \cos \beta \, e^{-\alpha z \sec \beta} \, d\beta, \quad (5)$$

for an observer looking down the runway with line of sight parallel to the luminaires. This will be referred to as *forward scattering*. The section of the luminaires behind the observer also produces a small heliosent in the fog. This is calculated from Equation 5 by replacing $\mu(\frac{\pi}{2} - \beta)$ by $\mu(\frac{\pi}{2} + \beta)$ and will be referred to as *backward scattering*. Calculated values of heliosent in the fog are given in Fig. 11.

Note that backward scattering is little more than 10 per cent of forward scattering for the examples considered here. Louvering of as much as 30 degrees will have negligible effect. Perhaps the most surprising result is the similarity of curves for moderate and dense runway fogs. This is the result of the natural louvering in fog.

The Illuminated Fog Layer

The most important way in which fog interferes with vision is by the reduction in contrast produced by the illuminated fog layer. The helios (brightness) of the illuminated fog layer, as viewed by the pilot (Fig. 12) is found by integrating the heliosent G along the line of sight. Since the illuminated layer of fog is very shallow with the type of luminaire described in Fig. 3, the heliosent may be taken as constant over the thickness of the illuminated fog layer. Thus, the helios (brightness) of the fog layer as viewed at the top of the illuminated fog layer in the direction of the pilot's line of sight is

$$H_{fo} = G \frac{d}{\sin \varphi} \quad (6)$$

where φ specifies the angle of the pilot's line of sight below horizontal and d is the thickness of the illuminated fog layer. The most important lines of sight for the pilot are from 0.5 degree to 15 degrees below horizontal. Perhaps the most important is the glide path at 2.5 degrees.

The resulting values of H_{fo} are calculated assuming that the pilot is seven meters (23 feet) above the runway, traveling above the center line of the runway along the glide path at a point opposite the end of the luminaires. The depth d of the illuminated fog is taken as 0.724 meters (28.5 inches). If the luminaires are tilted so that the cutoff plane is only 0.75 degree below horizontal, the depth of the illuminated fog layer is reduced to less than one-quarter of the value assumed in these calculations.

Calculated values of H_{fo}/H_s as a function of φ for unlouvered luminaires are given in Fig. 13. The surprising characteristic of Fig. 13 is that the dense runway fog scatters approximately the same

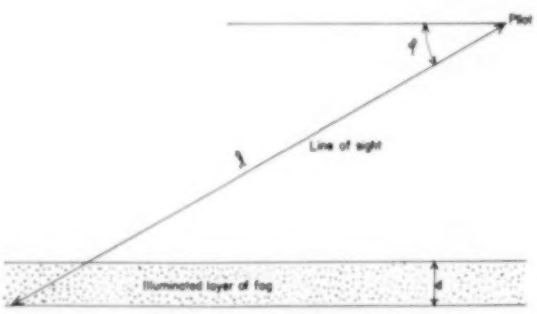

Figure 12. Pilot's view of illuminated fog layer.

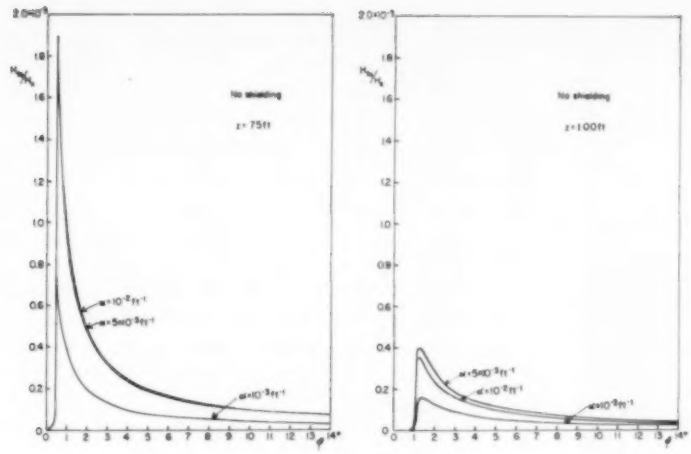

Figure 13. The illuminated fog layer for unlouvered luminaires.

amount of light back to the pilot as the medium runway fog and for values of φ greater than one degree scatters only about twice as much as the light runway fog.

A certain degree of shielding is necessarily introduced by the endcaps of the luminaires. At the center of the runway this corresponds to about seven degrees of louvering and as shown in Figs. 7, 8, 9 and 11 is entirely negligible. If further louvering is used, the scattering in the illuminated fog layer is further reduced as shown in Fig. 14. For example, if 60 degrees louvering is employed, only about one-sixth to one-tenth as much light is scattered toward the pilot in the illuminated fog layer; however, the **D**-vector at the center of the runway is cut in half. Extreme louvering could be valuable in some cases if pavement surfaces were perfectly diffusing, but preliminary measurements indicate that the pavement surface is far from diffusing at grazing angles of incidence. This increases the helios (brightness) of the pavement several hundred per cent. This increase would be entirely eliminated if extreme louvering were used. Thus, the decrease in helios (brightness) of the pavement associated with extreme louvering would more than compensate for the reduction of light scattered in the illuminated fog layer. An exact analysis of this problem cannot be made until measurements of the reflecting characteristics of pavement surfaces and markings are complete.

Attenuation in Fog

Both the helios (brightness) of the fog layer H_{fo} and the helios (brightness) of the pavement are attenuated by essentially the same factor, since $d<<l$ (Fig. 12). The attenuation reduces the helios that would be seen if viewed in fog at an angle φ. The ratio is

$$\frac{H}{H_o} = e^{-\alpha l}, \tag{7}$$

where l is the distance from the pilot to the run-

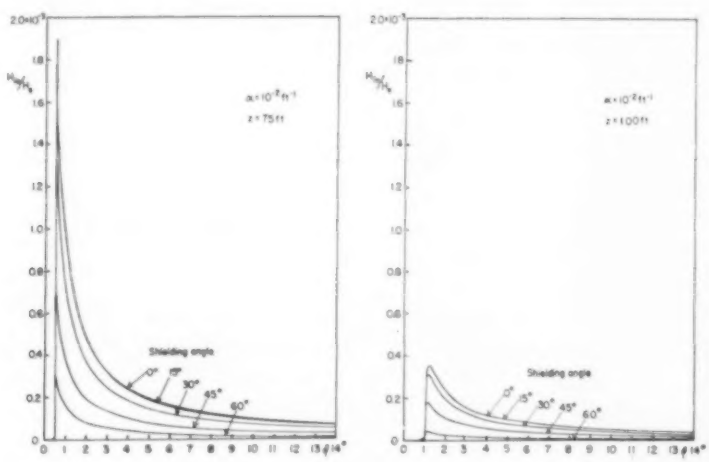

Figure 14. The illuminated fog layer for various amounts of louvering.

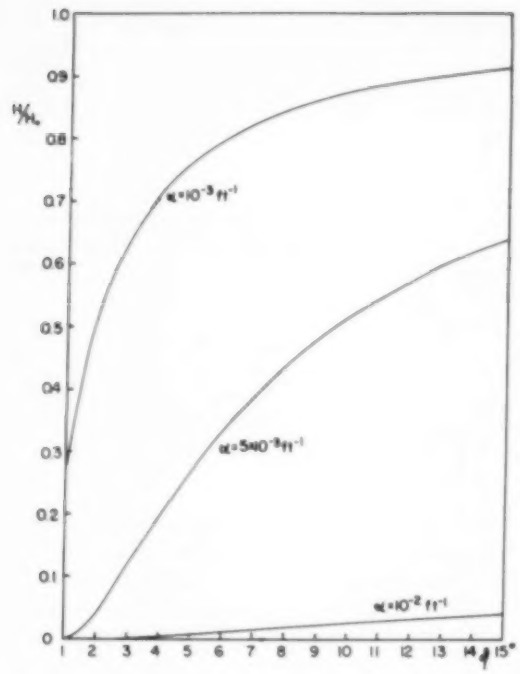

Figure 15. Attenuation by fog layer as a function of angle of view.

way surface in the direction of his line of sight. Graphs of H/H_o versus angle φ are shown in Fig. 15. In a light fog, the attenuation is small for most of the important lines of sight and H/H_o is still nearly 0.6 at the glide angle. In a moderate runway fog, the attenuation is much sharper and H/H_o is less than 0.1 at the glide angle. For the dense fog, H/H_o is less than 0.1 for all important lines of sight.

The exponential attenuation by the entire intervening fog layer between pilot and runway can neither be eliminated nor controlled. It is entirely unaffected by either extreme louvering or cross polarized filters. It serves to raise sharply the minimum perceptible contrast of runway markings.

In a thick runway fog, the **D**-vector at the center of the runway is still about one-third as large as in clear weather. Specular reflections from surface markings may be reduced by about one-tenth. The reduction in contrast produced by the veiling layer of illuminated fog may be moderate; but the attenuation in fog reduces the helios (brightness) of the runway as seen by the pilot by a factor of 1/1000.

Conclusions

Deleterious effects of fog on illuminated runways can be minimized by:

(a) Employing brighter lamps,
(b) Optimum tilting of cutoff plane below horizontal,
(c) Maximum permissible crowning of runway surfaces,
(d) Coarse details in runway surface,
(e) Development of surface markings of maximum contrast.

The paper has presented quantitative predictions of the light incident at the center of the runway in fog and of the scattering and attenuation produced in the fog layer between runway and pilot. The helios (brightness) distribution seen by the pilot cannot be predicted until goniophotometric measurements of reflectances of runway and marking surfaces are available. The response of the pilot can only be predicted when a summary of experimental data on minimum perceptible contrast as a function of state of adaptation, size and time of exposure become available. Future papers on both of these subjects are planned.

In conclusion, acknowledgment must be made to L. L. Montgomery of Sylvania Electric Products Inc., for faithful assistance in the calculations.

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IES Emblem

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FOG ON TURNPIKES

By DOMINA EBERLE SPENCER

THE OPTIMUM visual conditions for driving can be attained if:

(a) The road surface and all obstacles such as vehicles, animals, and pedestrians are illuminated, and yet

(b) The sources of light are designed in such a way that the driver can become adapted to the essential visual tasks without interference from direct or reflected glare.

The appearance of a section of turnpike designed to satisfy these conditions is shown in the foreground of Fig. 1. As all light is confined to a wedge below the driver's eyes, reflected glare is entirely eliminated and direct glare is negligible. The purpose of this paper is to evaluate quantitatively the effect of fog on such turnpike lighting.

Fog on turnpikes produces several effects:

(1) The fog between luminaire and turnpike modifies the incident light on the roadway.

(2) The entire layer of fog between the driver's windshield and the roadway attenuates the light reflected from pavement, vehicles, and pedestrians.

(3) A thin layer of illuminated fog below the driver's eye level reduces contrast of details in the essential visual tasks.

(4) Light scattered in the fog may raise the adaptation level above that at which the task can best be seen.

Another paper[1] describes the effect of fog on the illumination of runways by similar luminaires. However, a separate evaluation is needed for turnpikes because a different range of fogs are of significance and the observer is much closer to the ground and to the luminaires.

The Turnpike

The paper will study the lighting of a six-lane turnpike in fog (Fig. 2). Luminaires containing fluorescent lamps are arranged in a long, continuous line on the median strip at the center of the turnpike. The luminaires are of the type originally developed for runway lighting.[1] Macrofocal parabolas reflect the incident light from the lamp below a theoretical cutoff plane as shown in Fig. 3. Thus, the entire turnpike is flooded with a carpet of light, yet the driver is shielded from the direct glare which is characteristic of nearly all street lighting. Also the reflected glare from the hood and interior of the car, which is so troublesome with overhead lighting, is entirely eliminated. To keep the blanket of illuminated fog as thin as possible, the cutoff plane is rotated 4.15 degrees below

Figure 1. Test lighting on New Jersey Turnpike.

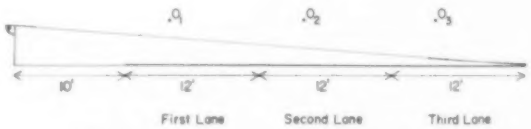

Figure 2. The turnpike configuration.

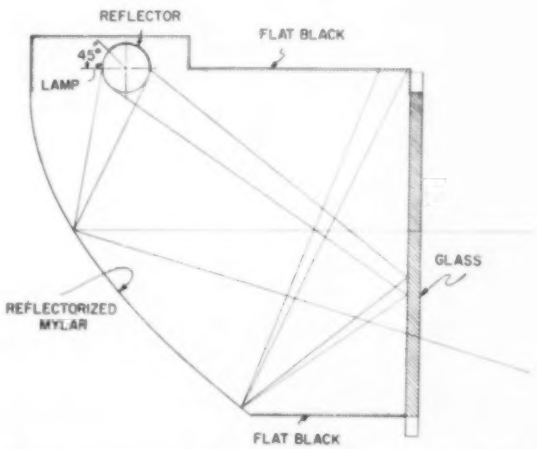

Figure 3. Cross section of the fluorescent luminaire which is shown in Fig. 1.

AUTHOR: University of Connecticut, Storrs, Conn.

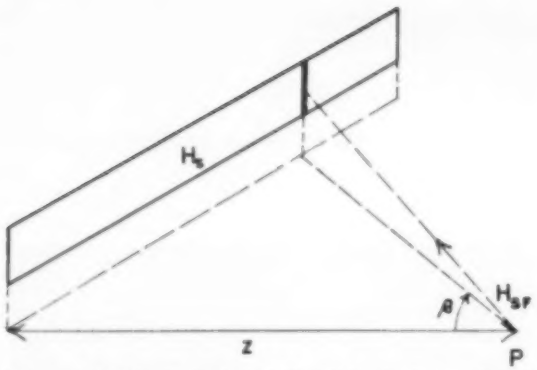

Figure 4. Helios (brightness) H_{sf} of luminaire as viewed from surface of turnpike.

horizontal as shown in Fig. 2. If the luminaires are installed in a continuous line along the median strip, save for the effect of endcaps, louvers, and window mullions, the strip luminaires may be treated as long, thin rectangular sources extending 0.254 meters (10 inches) downward from the cutoff plane and perpendicular to it. The bottom of the luminaire is 0.763 meters (2.50 feet) above the ground. The traffic lanes in Fig. 2 are assumed to be 3.66 meters (12 feet) wide. The driver is assumed to be 1.22 meters (4 feet) from the left side of the traffic lane with his eye level 1.22 meters (4 feet) above the roadway. Visual conditions in each traffic lane will be studied.

Turnpike Fogs

Fogs in which traffic is expected to move on turnpikes are much denser than those previously studied on runways[1] as speeds of vehicles are less and distances at which significant markings must be recognized are correspondingly decreased. Thus the densest fog considered on the runway becomes the light fog on the turnpike:

Light turnpike fog, $\alpha = 3.28 \times 10^{-2}\ m^{-1} = 10^{-2}\ ft^{-1}$,

Moderate turnpike fog, $\alpha = 1.640 \times 10^{-2}\ m^{-1} = 5 \times 10^{-2}\ ft^{-1}$,

Thick turnpike fog, $\alpha = 3.28 \times 10^{-1}\ m^{-1} = 10^{-1}\ ft^{-1}$.

These attenuation coefficients correspond to meteorological visual ranges in daylight of 91.6 meters (300 feet), 18.3 meters (60 feet), 9.16 meters (30 feet), or to the thickness of fog which has a transmittance of 0.05. As pointed out in a previous paper,[2] the attenuation coefficient may be used as a single-number specification which also predicts the scattering coefficient of the fog.

Luminaire as Viewed from Surface of Turnpike

In clear weather, the helios (brightness, if defined in terms of a lightcone which converges at the observer) of the luminaire as viewed below the cutoff plane is a constant H_s. In a fog, the helios (brightness) H_{sf} of the luminaire, as viewed from the surface of the turnpike is reduced exponentially. The ratio by which the helios is cut down depends on the distance the light must travel in the fog, Fig. 4, or on the distance z and the angle β,

$$H_{sf} = H_s\, e^{-\alpha z \sec \beta}, \qquad (1)$$

if z is large compared with the height of the luminaire above the turnpike surface. Results calculated from Equation 1 in each of three traffic lanes and for each type of fog are shown in Fig. 5. In

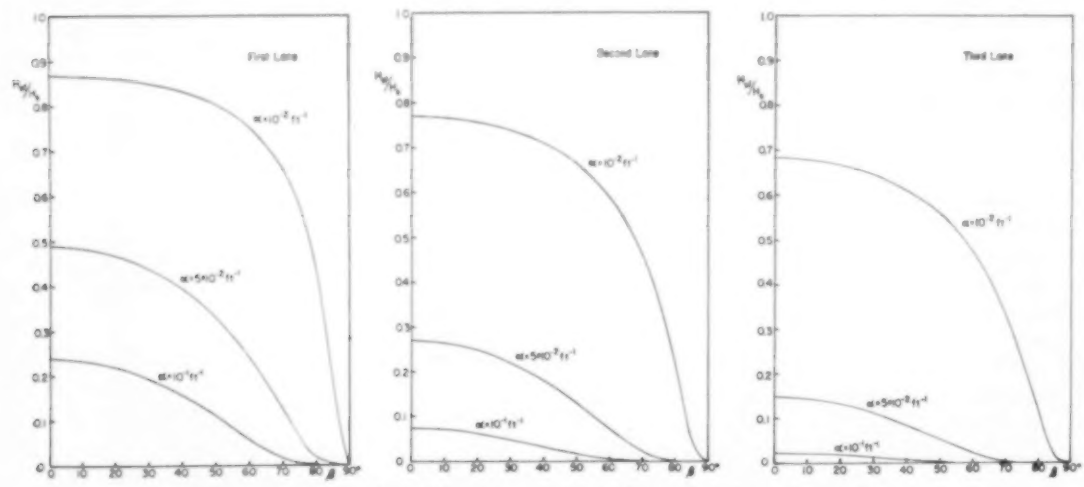

Figure 5. Attenuation of fog between luminaire and surface of turnpike.

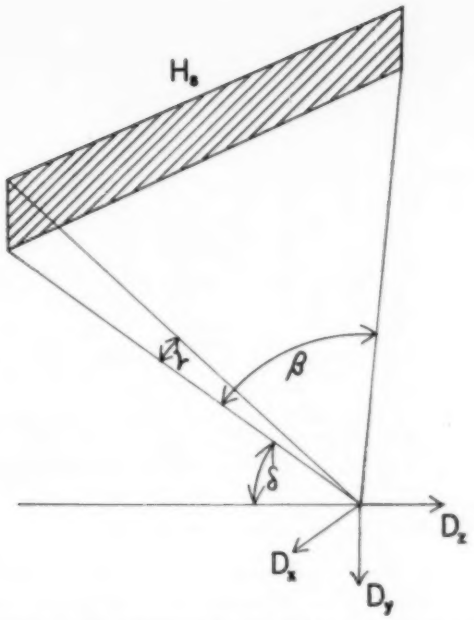

Figure 6. The pharosage (illumination) vector *D* specifies incident light on turnpike surface and on vehicles and other obstacles.

both moderate and dense fogs, the contribution beyond 60 degrees is very small. Thus, a natural louvering effect is introduced by the fog.

Incident Light at Surface of Turnpike

The appearance of any perfectly diffusing obstacle on the road can be calculated if the three components of the pharosage (illumination) vector **D** are known. The luminaire subtends angles β and γ at a point on the surface of the turnpike as shown in Fig. 6. The position of the bottom of the luminaire is specified by the angle δ which is different for each traffic lane. In clear weather, if the angle γ is small, the three components[3] of the **D**-vector are given by the equations,

$$\begin{cases} D_x = \dfrac{H_s \gamma}{2\pi} \sin^2 \beta, \\ D_y = \dfrac{H_s \gamma}{2\pi}\left[\dfrac{\beta\gamma}{2}\cos\delta + (\beta + \sin\beta\cos\beta)\sin\delta\right], \\ D_z = \dfrac{H_s \gamma}{2}\left[(\beta + \sin\beta\cos\beta)\cos\delta - \dfrac{\beta\gamma}{2}\sin\delta.\right]. \end{cases} \quad (2)$$

As in the runway example,[2] an integration must be performed to evaluate the corresponding components in fog,

$$\begin{cases} D_{xf} = \dfrac{H_s \gamma}{2\pi}\displaystyle\int_o^\beta \sin 2\beta \; e^{-\alpha z} \sec\beta \; d\beta, \\ D_{yf} = \dfrac{H_s \gamma}{2\pi}\left[\dfrac{\gamma\cos\delta}{2}\displaystyle\int_o^\beta e^{-\alpha z}\sec\beta\, d\beta \right. \\ \qquad \left. + \sin\delta \displaystyle\int_o^\beta (1+\cos 2\beta)\, e^{-\alpha z}\sec\beta\, d\beta\right], \quad (3) \\ D_{zf} = \dfrac{H_s \gamma}{2\pi}\left[\cos\delta \displaystyle\int_o^\beta (1+\cos 2\beta)\, e^{-\alpha z}\sec\beta\, d\beta \right. \\ \qquad \left. - \dfrac{\gamma\sin\delta}{2}\displaystyle\int_o^\beta e^{-\alpha z}\sec\beta\, d\beta\right]. \end{cases}$$

The x-component of the **D**-vector is plotted as a function of β in Fig. 7 for clear weather and for fog in each of the three traffic lanes. This component of **D** specifies the number of lumens per unit

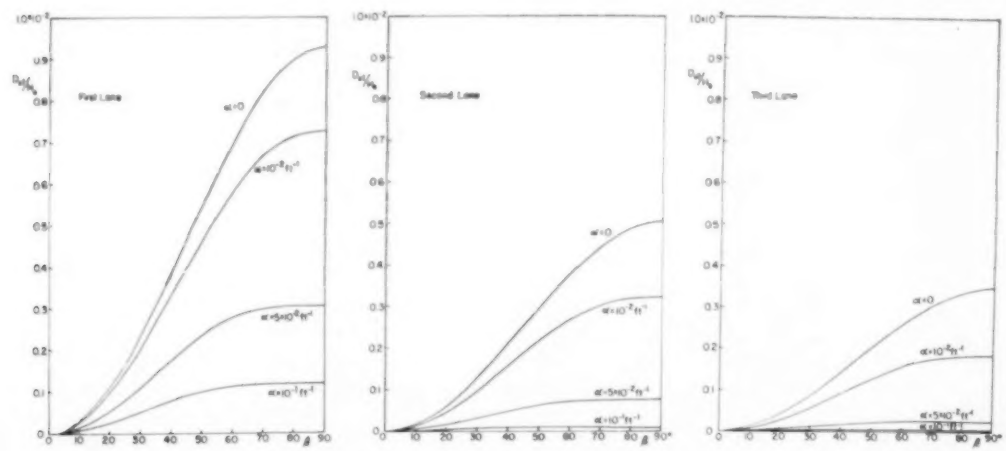

Figure 7. The *x*-component of the *D*-vector at the surface of the turnpike at points 1.22 meters (four feet) from the left side of each traffic lane in clear weather and in fog.

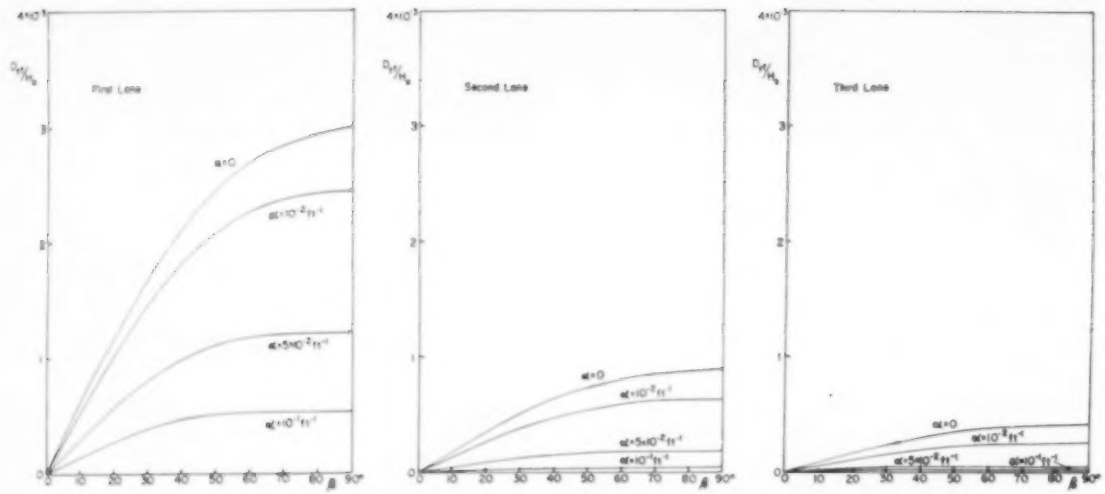

Figure 8. The *y*-component of the *D*-vector at the surface of the turnpike at points 1.22 meters (four feet) from the left side of each traffic lane in clear weather and in fog.

area incident on a vertical surface which is facing the driver (such as the back of a truck). Consider the case of a very long row of luminaires. Then $\beta = 90$ degrees. The variation of D_x from first to third lane is by a factor of only 2.66; it becomes 3.97 in a light turpike fog, 12.78 in a medium fog, and 45 in a dense turnpike fog. Thus the uniformity of distribution of incident light is excellent in clear weather and in light fogs. It is still fair in a medium fog, but in a dense fog, there is considerable variation. Consider also the comparison between D_x in clear weather and in a dense fog. In the first traffic lane a dense fog decreases D_x by a factor of 7.88, in the second lane by 50.5 and in the third lane by 133.

The component D_y specifies the light incident on a horizontal road surface. Values are plotted in Fig. 8. For a very long row of luminaires, in clear weather D_y varies from first to third lanes by a factor of 7.31, in a light fog by 9.70, in a medium fog by 28.0, and in a dense fog by 98.0. A dense fog reduces the quantity of light incident on a horizontal surface by 5.58 in the first traffic lane, 21.0 in the second lane and 77.0 in the third lane.

The z-component of the pharosage (illumination) vector (Fig. 9) specifies the light incident on a vertical surface which is parallel to the luminaires. It is useful in specifying the light incident on the sides of vehicles. It is also useful in specifying the light incident on the roadway if there is an ap-

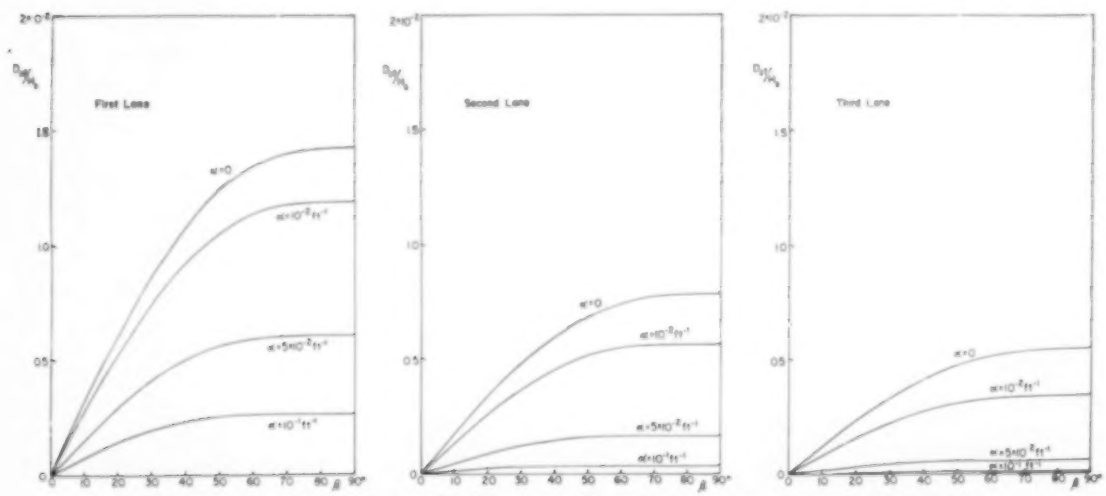

Figure 9. The *z*-component of the *D*-vector at the surface of the turnpike at points 1.22 meters (four feet) from the left side of each traffic lane in clear weather and in fog.

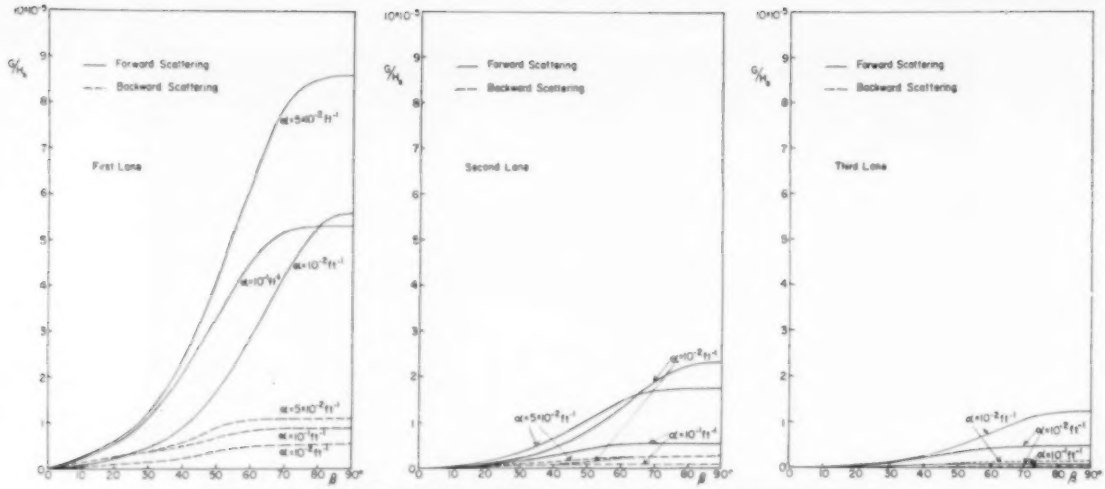

Figure 10. Heliosent in fog produced by forward and backward scattering.

preciable crown. This component is more uniform than either the x- or y-components. For a long row of luminaires, in clear weather, the z-component of **D** varies by only 2.62, in a light fog by 3.50, in a medium fog by 10, and in a dense fog by 35.6. In the first lane a dense fog reduces D_z by a factor of 5.30, in the second by 20, and in the third by 72.6.

Thus, the **D**-vector is essentially unchanged even in a dense fog in the first lane. The second lane is also well-lighted in a moderate fog, and all three lanes are well-lighted in a light fog.

The denser the fog, the more pronounced the natural louvering effect. In a light fog the section of the luminaire beyond $\beta = 70$ degrees contributes a negligible amount of incident light. A light fog introduces approximately 20 degrees of natural louvering. A moderate fog extends the natural louvering angle to about 30 degrees while in a very dense fog it reaches about 45 degrees. Therefore, we can conclude that artificial louvers (up to 45 degrees) built into the luminaire would have no effect on the incident light in a dense fog but would seriously reduce the quantity of light available in good weather.

Illuminated Fog Layer

The heliosent G on the foggy turnpike is calculated exactly as in the paper[1] published on page 436 of this issue. The results are shown in Fig. 10, both for forward scattering associated with light from the part of the luminaire ahead of the driver and the backward scattering associated with the remaining portion of the luminaire.

Consider the ratio between the general scale of the curves of D_{fy}/H_s as compared to G/H_s. There is roughly a ratio of 50:1 between G and D_{fy}. The ratio is larger by an order of magnitude for the other components of **D**. Thus, it appears that the helios (brightness) of the layer of illuminated fog may be low compared to that of obstacles, even for objects at satisfactorily large distances. Exact calculations cannot be made until data are available on the goniophotometric reflectances of pavements and obstacles and until visual data on minimum perceptible contrast have been satisfactorily summarized.

Conclusions

The results presented in this paper indicate that it is possible to illuminate turnpikes satisfactorily even under unfavorable fog conditions. If the luminaires illuminate the road surface and the lower part of vehicles and obstacles, while all of their light is confined to a region close to the road surface, the effect of the fog can be minimized. Sharp cutoff and accurate construction of the macrofocal parabolic reflectors are of great importance, as is accurate adjustment of the tilt of the cutoff plane.

Final conclusions must await further work on goniophotometric reflectance and visual data. However, what information is available leads us to expect that at least one lane of the turnpike can be kept open even in the densest fog and that all three lanes will be useable in light fogs.

The able and ready assistance of L. L. Montgomery of Sylvania Electric Products Inc. in the lengthy calculations is hereby acknowledged.

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INSTALLATION AT LINCOLN AVENUE STORAGE GARAGE FOR CITY OF MILWAUKEE, 3921 WEST LINCOLN AVE., MILWAUKEE, WIS.

Lighting a Garage Wash Area

LIGHTING OBJECTIVE: To illuminate the sides, front and rear of cars and trucks in the wash area of a garage to facilitate the washing.

GENERAL INFORMATION: The above photograph shows one of two 25-foot 6-inch by 60-foot wash areas in this city garage. The ceiling height is 18 feet 6 inches, but the areas are divided by concrete block walls only 14 feet in height. Colors and reflectances of the major surfaces in this part of the garage are: ceiling, grey (15 per cent reflectance); walls, salmon marblox glazed finish (33 per cent reflectance); floor, concrete (20 per cent reflectance).

INSTALLATION: Side, front and rear lighting is provided by 14 Holophane catalog No. U-818M prismatic glass lens units, vertically mounted on 8-foot centers on both side walls. Lower row is 18 inches above floor; upper row is 7 feet above floor. Each unit is equipped with a 300-watt clear incandescent lamp. Units in the bottom row have lenses positioned so that most of their light is directed outward and upward while the units in the top row have most of their light directed outward and downward. Additional lighting is provided by 12 Steber catalog No. S-400 lampholder units, each equipped with a 300-watt PAR-56 flood lamp. These units are mounted on about 12-foot centers at the top of the concrete block walls, as shown above.

Initial meter reading without a vehicle in the area showed that the illumination on the floor along the centerline varied from 40 to 100 fc, horizontal, and 60 to 130 fc, vertical. However, readings with a truck in position showed that the illumination at the wheels varied from 30 to 40 fc and averaged 125 fc on the sides.

Lighting designed by Bureau of Bridges and Public Buildings, City Hall, Milwaukee, Wis. Superintendent, George Ashton; assistant superintendent, Larry Hager. Designing electrical engineer, Norb. Langkammer.

Lighting data submitted by Edward H. Grieb, district manager, Holophane Co., and Jim Augustine, lighting consultant, Milwaukee, Wis., as an illustration of good lighting practice and to aid in the design of similar installations.

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Light Source with Long-Duration Flash

By STEVE B. GIBSON
STANLEY M. SEGAL

Instantaneous flashes of short duration are in common use today. A brilliant flash of long duration, not quite so common, is described in this paper.

In recent years, many flashing sources have been developed which have exhibited very high momentary brightnesses. The durations of these flashes have been in the millisecond, microsecond and even in the submicrosecond ranges. However, a high intensity flashing light source in the duration range of 0.1 second to 1.0 second was needed as a component of experimental image intensifier readout systems. Such a long-duration flashing source was developed in 1959[1] and this paper describes the resulting electrical and photometric characteristics.

The lamp, Fig. 1, is a compact arc type with a fused silica envelope filled with 7 to 10 atmospheres of xenon gas at room temperature. The electrode separation is 4.5 millimeters and the over-all length of the lamp is 270 millimeters. The electrodes are of tungsten and the lead-in strips through the seal are of molybdenum.

Authors: U. S. Army Engineer Research and Development Laboratories, Ft. Belvoir, Va.

The light source system, Fig. 2, incorporates two assemblies—a power supply and a searchlight drum. The power supply consists of fourteen 12-volt, 100-ampere-hour batteries which supply the power to the lamp, a 115-volt, 60-cycle inverter and a 115-volt, 400-cycle inverter. The searchlight drum supports the high-frequency high-voltage lamp starter, a parabolic reflector and the lamp holder-focusing mechanism.

The system is controlled by an electro-mechanical timing device driven by the 115-volt, 60-cycle inverter. The control console, Fig. 3, allows the selection of flash durations from 0.1 second to 1.0 second with an off-cycle interval of 15 to 30 seconds. The

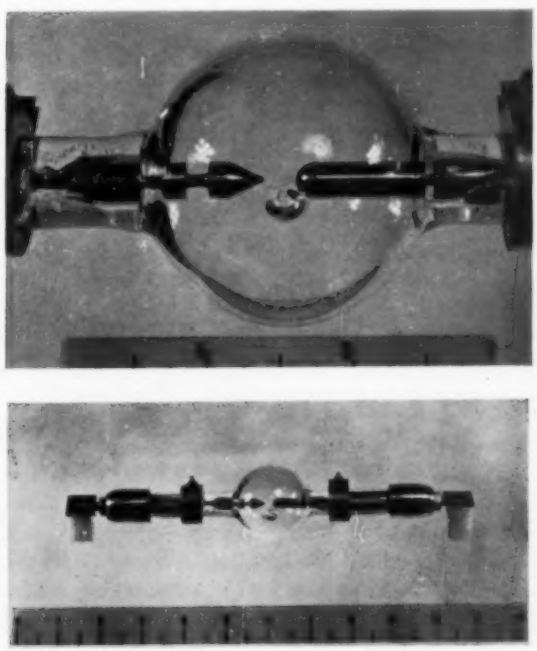


Figure 1. Xenon compact arc flashing light source.

Figure 2. Components of flashing light source, power supply and searchlight drum.

Figure 3 (below). Control console of flashing light source.

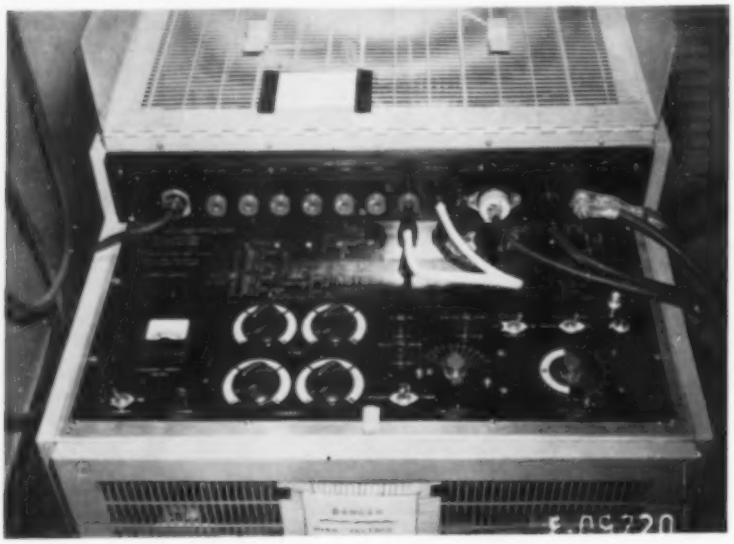
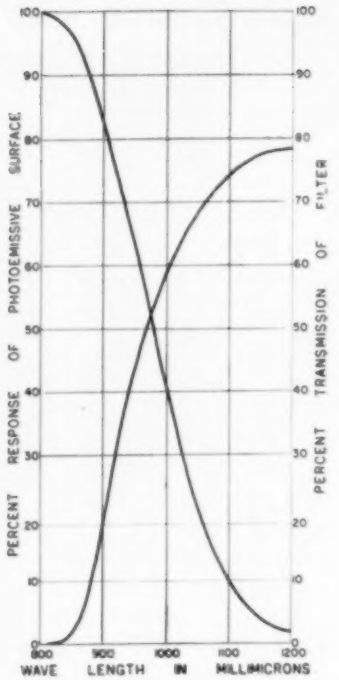


Figure 4 (right). Band pass of infrared detector and filter combination employed for relative infrared measurements.



flash is automatically repeated at any duration and interval setting within the above limits. The light source may also be operated manually or from a remote external circuit. The lamp is ignited by the high-frequency high-voltage starter driven by the 115-volt, 400-cycle inverter and controlled by the timing device. By selecting the proper current jack on the control console the lamp may be flashed at currents of 40, 100, 125, 150, 175, 200, and 225-250 amperes. The lamp may also be operated as a continuous d-c source at the lower current settings.

The electrical and photometric measurements of the flashing light source were made simultaneously with a 24-channel Hathaway S8-B recording oscillograph. The arc current and arc voltage measurements were recorded on one side of the 25-centimeter photographic record, with their zero lines separated by one centimeter, and the photometric data were recorded on the opposite side. (This is shown later in Fig. 12.) Time lines were recorded automatically by the oscillograph's synchronous time marking motor driven by a calibrated tuning fork vibrator. The brightness distribution charts of the lamp when operated as a continuous d-c source were obtained from recorded scans across the arc image. The arc image was obtained by an optical system giving a magnification of 50. The speed of the scanning motor and the recorder chart were the same, making possible the overlaying of the chart curves on a sketch of the arc image to obtain corresponding points. The scans were made horizontally across the vertical arc image at intervals corresponding to 0.2 millimeters in the lamp arc. Therefore, the block diagram of the brightness distribution is a composite of many continuous recorder chart curves. The infrared radiance per unit area distribution during continuous operation was obtained by this same procedure.

The detector used for the visible brightness measurements was a barrier layer cell corrected to match eye sensitivity, stopped to one-quarter inch, and baffled against stray light. The recording circuit was calibrated to read galvanometer deflections directly in candles per square millimeter. The infrared radiance per unit area was measured by the same procedure as the visible brightness by substituting an image intensifier tube with an RETMA standard filter (Corning No. 2540, 2.60 millimeters, melt 1613) for the barrier layer cell. Fig. 4 defines the band pass of the infrared detector and filter combination. The infrared recording circuit was calibrated to read the galvanometer deflection in values relative to a tungsten ribbon filament source operated at a color temperature of 2870 degrees Kelvin. This relative value multiplied by seven gives the brightness in "holocandles" per square millimeter for the spectral range indicated in Fig. 4; or multiplied by 0.0025 it gives the radiance in watts per steradian per 10-millimicron interval per square millimeter.[2]

The radiance diagrams, Figs. 5 and 6, of the visible brightness distribution show the arc length

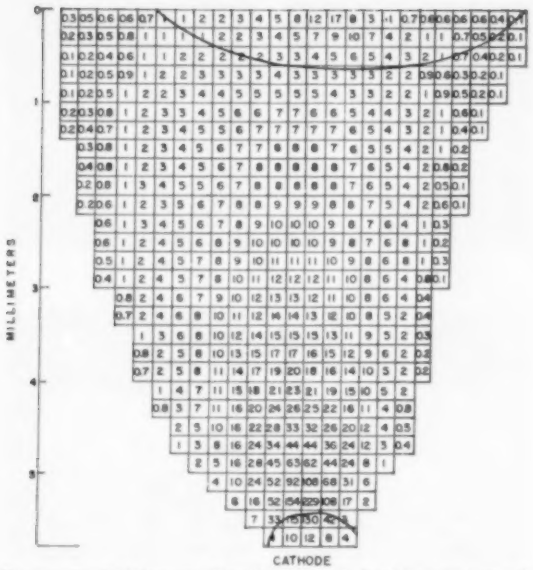


Figure 5. Brightness distribution of the lamp operated continuously at 25 volts and 35 amperes. Each block represents 0.04 square millimeter. The value in each block times ten is candles per square millimeter.

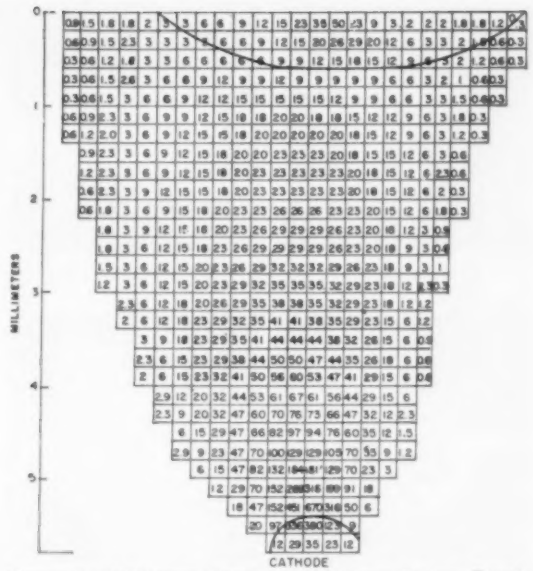


Figure 6. Brightness distribution of lamp during a flash of 0.3 second duration at 61 volts, 195 amperes. Each block represents 0.04 square millimeter. Value in each block times ten is candles per square millimeter.

and are configuration. The value in each square represents the brightness of a circular area of 0.013 square millimeter. Fig. 5 is the brightness distribution of a lamp operated continuously at 25 volts and 35 amperes. Fig. 6 is a diagram of the same lamp extrapolated from the distribution in Fig. 5 for a flash of 0.3-second duration at 61 volts and 195 amperes. This extrapolation was aided by numerous spot measurements over the high wattage arc. The peak brightness of this lamp during con-

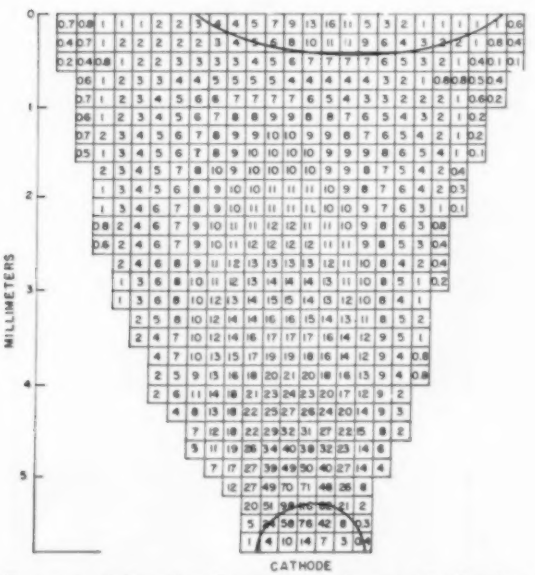


Figure 7. Infrared radiance per unit area distribution of lamp operated continuously at 24.2 volts, 35 amperes. Each block represents 0.04 square millimeter; relative value in each block times seven is "holocandles" per square millimeter or times 0.0025 is watts per steradian per 10 millimicron interval per square millimeter.

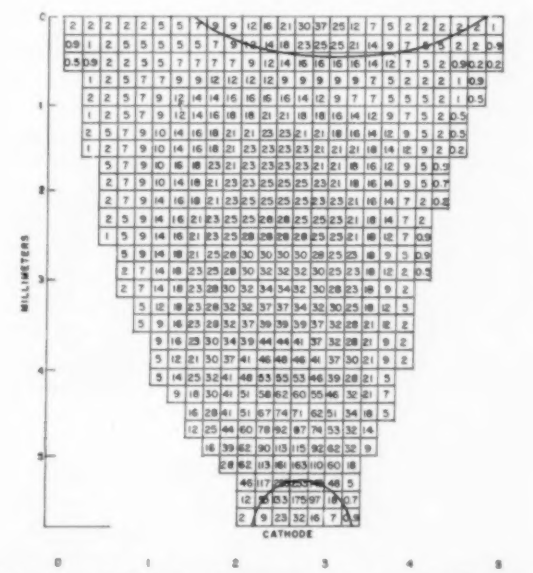
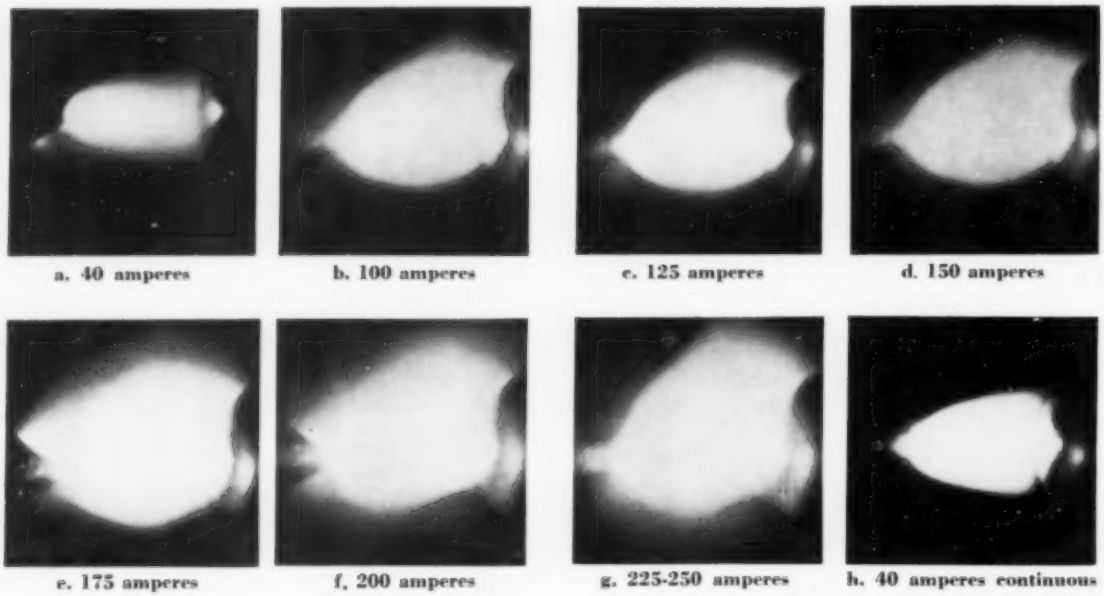


Figure 8. Infrared radiance per unit area distribution of lamp during 0.3 second duration flash at 60 volts, 200 amperes. Each block represents 0.04 square millimeter; relative value in each block times seven is "holocandles" per square millimeter or times 0.0025, watts per steradian per 10 millimicron interval per square mm.



a. 40 amperes b. 100 amperes c. 125 amperes d. 150 amperes

e. 175 amperes f. 200 amperes g. 225-250 amperes h. 40 amperes continuous

Figure 9. Characteristics of 0.5 second flashes at various current values with lamp in horizontal position and a continuous arc at 40 amperes.

tinuous operation was 2290 candles per square millimeter and the peak brightness during the flash was 6700 candles per square millimeter. The average brightness over an area of ten square millimeters in the lamp arc in Fig. 4 is 158 candles per square millimeter, while the average instantaneous brightness of the flash over the same area is 463 candles per square millimeter.

Figs. 7 and 8 diagram the distribution of the infrared radiance per unit area. The values in the squares represent the infrared radiance relative to a 2870-degree Kelvin C.T. tungsten source. Fig. 7 is the infrared distribution of the lamp operated continuously at 24.2 volts and 35 amperes. Fig. 8, extrapolated by the same procedure as the visible brightness in Fig. 6, is the infrared distribution of a 0.3-second flash at 60 volts and 200 amperes. The peak infrared radiance for the continuous arc was 770 "holocandles" per square millimeter, while the instantaneous peak during the flash was 1770 "holocandles" per square millimeter. Again, this means "holocandles" under the curves in Fig. 4; in absolute units these two values are, respectively, 0.295 and 0.632 watts per steradian per 10-millimicron interval per square millimeter. The photographs *a* through *g* in Fig. 9 show the characteristic arc configurations of 0.5-second flashes at varying current values with the lamp operating in the horizontal position. These photographs demonstrate the change in arc configuration with currents between 40 and 250 amperes. Photograph *h* in Fig. 9 is of a continuous arc operated horizontally at 40 amperes. Variations in instantaneous peak brightness, although not apparent from the photographs, were substantial. This may be seen from Fig. 10 which shows the relationship between the increase in instantaneous peak brightness and the increase in instantaneous volt-ampere values for 0.5-second flashes at currents varying from 40 to 200 amperes.

Fig. 11 is a diagram of the increase in the instantaneous peak brightness of the arc with an increase in the time duration of the flash, keeping the current constant. The lamp was flashed at 100 amperes at times varying from 0.1 second to 1.0

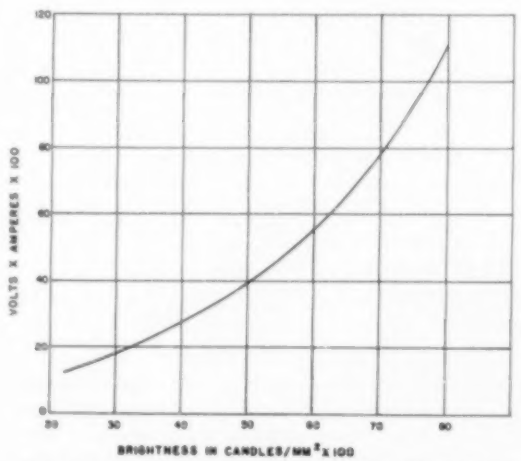


Figure 10. Variation of peak brightness with increases in power during flashes of 0.5-second duration.

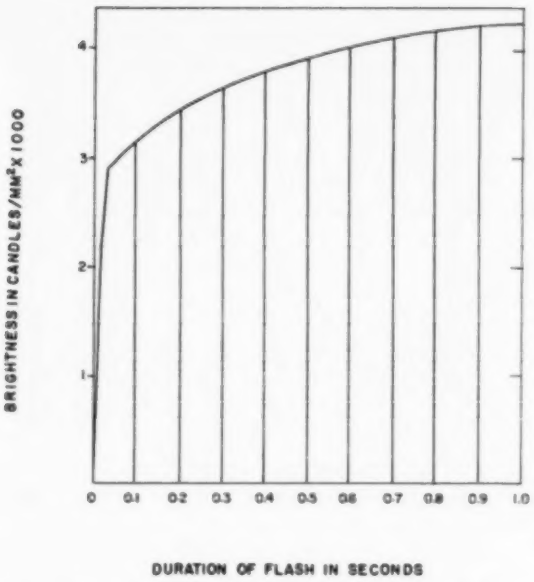


Figure 11. Peak brightness variation with duration time for 100-ampere flashes.

second, and the graph was obtained from the corrected oscillograph curves. The peak brightness increases from 3200 candles per square millimeter during the flash of 0.1 second to 4300 candles per square millimeter for the flash of 1.0 second.

Fig. 12 shows representative raw data obtained with the oscillograph. These charts show the relationship of the brightness of the flash to the instantaneous arc voltage and arc current during the flash. They also show the open circuit potential applied to the arc from the battery power supply. The high RF voltage was not recorded since it was damped out by inductance coils between the lamp and the voltage test points. The ignition time lag is obtainable from the time lag between the rise of the open circuit potential and the rise in current;

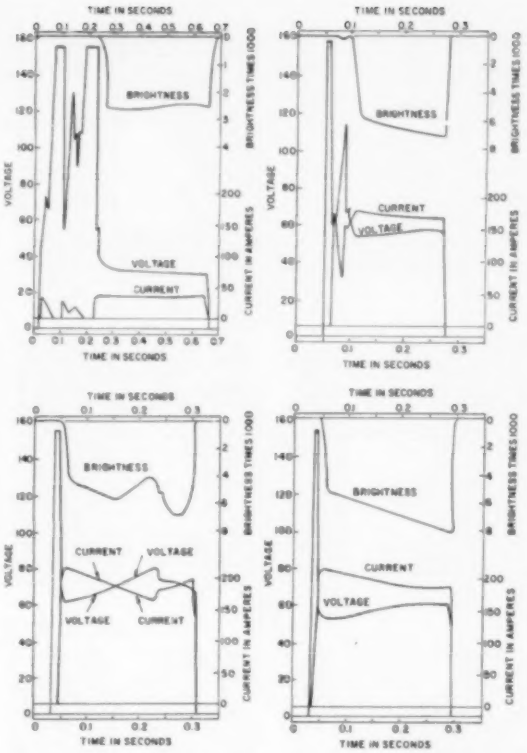
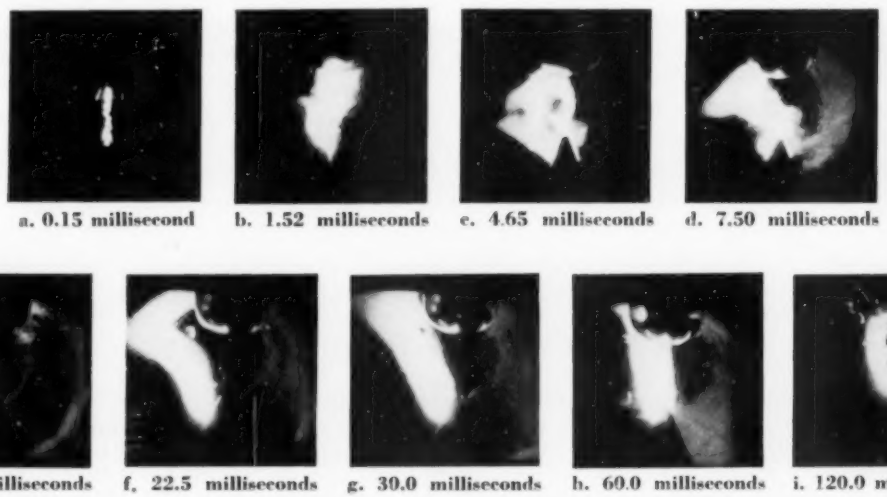


Figure 12. Representative samples of records obtained on the oscillograph showing ignition time and volt-ampere-brightness relationship. Brightness is in candles per square millimeter.



a. 0.15 millisecond b. 1.52 milliseconds e. 4.65 milliseconds d. 7.50 milliseconds

e. 15.0 milliseconds f. 22.5 milliseconds g. 30.0 milliseconds h. 60.0 milliseconds i. 120.0 milliseconds

Figure 13. Starting characteristics for a low intensity flash from a cold start.

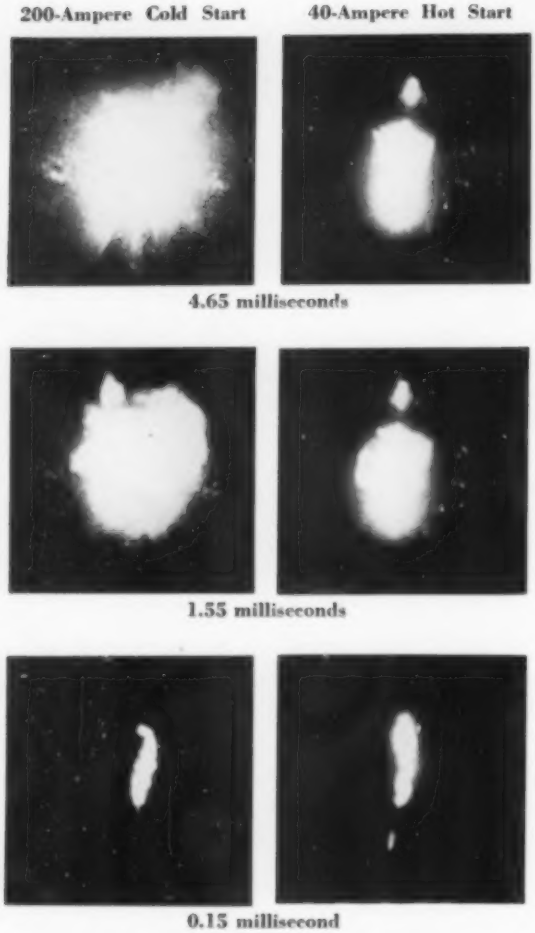


Figure 14. Comparison of starting characteristics of high and low current flashes.

the duration of the flash is also obtainable from the rise and fall of the current and brightness. The rapid current rise upon ignition and the relationship of the arc voltage and arc current to the state of ignition are also apparent, as is the rapid response time of the oscillograph's galvanometers. The galvanometer lag time, though small, was measured and all the data were corrected accordingly.

High speed motion pictures were made of the lamp are during high-current and low-current flashes of 0.3 second in duration. The operation of the arc during the flashes was photographed at approximately 8000 frames per second on 16-millimeter film. The lamp was flashed at 40 amperes and photographed both during hot starts and cold starts. This was repeated for 200 amperes during cold starts only. Upon ignition, the high current flashes became stable within 0.01 second; but on the low current flashes formation of a stable discharge often consumed more than 0.1 second. Since the lamp was unstable during the low intensity cold-start flashes, it was decided to preheat the lamp electrodes by operating the lamp for one minute at 40 amperes and then flashing it after the off-cycle of 15 seconds. The electrodes were still glowing red when flashed, and the arc was stable and ignited very quickly during the flash.

The photographs in Fig. 13, taken from selected frames of the high-speed film, show the ignition and arc characteristics of a 40-ampere flash from a cold start. The instability or hunting characteristic is shown by the moving of the gaseous discharge over the surfaces of the anode and cathode before the stable arc is formed. Fig. 14 compares the ignition and arc characteristics of a 200-ampere cold-start flash and a 40-ampere hot-start flash. It is evident that both of these arcs form very rapidly as compared to the 40-ampere cold-start flash shown in Fig. 13.

Whereas these sources proved valuable to image intensifier read-out systems presently under development, it is very probable that other uses may be found for this type of a high intensity flash of long duration.

The authors take pleasure in acknowledging the encouragement and advice of Dr. Robert S. Wiseman, and the photography of Eugene T. Chapman.

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2. Segal, Stanley M.: "A Study of High Intensity Light Sources," ILLUMINATING ENGINEERING, Vol. L, No. 5, May 1955.

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Registration forms and complete program information for the National Technical Conference, September 24-29 in St. Louis, Mo., have been mailed to all members. Plan to attend the Conference and return your registration *now*.

INSTALLATION AT FLOWERS BY HUTCHINGS, 19600 GRAND RIVER AVE., DETROIT, MICH.

Lighting a Florist Shop

LIGHTING OBJECTIVE: To provide an attractive environment with general and supplementary lighting for the display and sale of flowers.

GENERAL INFORMATION: The photograph above shows the main display and sales area of this inviting florist shop. The ceiling height here is 8 feet 6 inches. Fig. 2 shows another display area with a refrigerated wall case. The ceiling height here is 10 feet 6 inches with one section dropped to 8 feet 6 inches above the floor. This dropped ceiling section consists of 2-foot by 8-foot blue, green and lavender painted panels alternating with plastic Circlgard louvering. A scaled plan view of the entire store is shown in Fig. 3. Colors and reflectances of the major store surfaces are:

ceiling	white	80% RF
walls	white	85% RF
shelving	white	85% RF
display wall	quail	20% RF
refrigerated case	quail	20% RF
floor	light grey	50% RF

INSTALLATION: As is illustrated in Fig. 3, illumination is provided by the following: three Keystone Infinolite 2- by 2-foot plastic enclosed recessed units, each equipped with four 20-watt T-12 deluxe cool white lamps (square symbol); 20 Camber Lighting catalog No. 920 recessed down-

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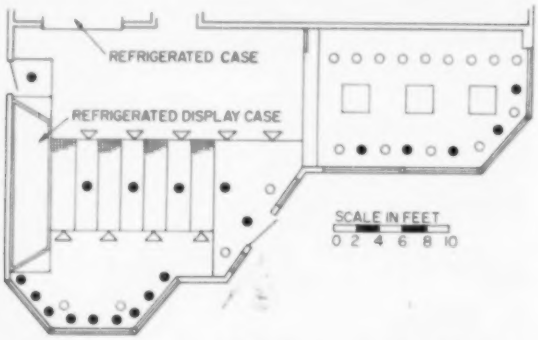

Figure 2 (left). View of display area with refrigerated wall cases.

Figure 3 (above). Scaled plan view with sales and display areas.

lights, each equipped with one 150-watt R-40 flood lamp (solid circle symbol); nine Camber catalog No. 6140 adjustable floodlighting units, each equipped with one 150-watt R-40 flood lamp (triangle symbol); and 18 Camber catalog No. 500 recessed adjustable downlights, each equipped with one 150-watt R-40 flood lamp (open circle symbol).

Two 2-lamp channels, each equipped with 96-inch T-12, 425-ma deluxe warm white fluorescent lamps, and three 150-watt R-40 flood lamps in adjustable holders provide lighting within the refrigerated display case.

The average general level of illumination ranges from 40 to 50 footcandles with 250 footcandles at displays. Brightnesses are:

fluorescent luminaire at 45 degrees	450 fL
ceiling	45 fL
wall at candle display	85 fL
display wall	50 fL
lower display shelves	180 fL

Lighting designed by Richard Royal, Commercial Designer, Troy, Mich.

Lighting data submitted by Walter Reeves, The Detroit Edison Co., Detroit, Mich., as an illustration of good lighting practice and to aid in the design of similar installations.

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IES Guide for Measurement of Photometric Brightness (Luminance)

Prepared by the Subcommittee on Guide for Measurement of Photometric Brightness of the Committee on Testing Procedures of the Illuminating Engineering Society

FOREWORD

The use of brightness measurements is becoming increasingly important in designing today's luminous environments. This guide, which has been under development for eight years, includes the latest information on brightness measuring methods and devices to aid in that direction.

SUBCOMMITTEE ON GUIDE FOR MEASUREMENT OF PHOTOMETRIC BRIGHTNESS (LUMINANCE)

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*Alternate

1. Purpose and Scope

The purpose of this guide for brightness measurements is to provide a practical background and method of measurement of the concept of brightness as defined by the IES Nomenclature Committee. It is earnestly hoped that by doing so the greatest number of people may be best served by promoting a uniform method of measuring and reporting this quantity.

Approved by the Council of the Illuminating Engineering Society, April 1961. A Transaction of the IES.

2. Definition

(a) Photometric brightness (luminance) is the luminous flux per unit of projected area per unit solid angle, either leaving a surface at a given point in a given direction, or arriving at a given point from a given direction; or it is the luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction.

(b) The formula for photometric brightness (luminance) is:

$$B = d^2F/d\omega(dA \cos \theta)$$
$$= dI/(dA \cos \theta)$$

in which θ is the angle between the direction of observation and the normal to the surface.

(c) In common usage, the term brightness usually refers to the intensity of "sensation" which results from viewing surfaces or spaces from which light comes to the eye. This sensation is determined, in part, by the definitely measurable "photometric brightness" defined above, and, in part, by conditions of observation such as the state of adaptation of the eye.

(d) Since photometric brightness is luminous intensity per unit area, a simple method of measuring brightness would be to measure the intensity normal to the surface and divide this by the area of the surface in question. This is the average photometric brightness of the surface. For directions other than the normal to the surface, the brightness is the intensity in a given direction divided by the projected area of the luminous surface, *i.e.*, the area of the luminous surface times the cosine of the angle between the normal to the surface and the line of measurement. It is for the practical measurement and reporting of this value that this Guide is presented.

3. Principles of Brightness Measuring Instruments

3.1—*Visual Theory and Optical Measuring Equipment*—(a) Visual brightness instruments are subject to all the difficulties which beset visual photometric measurements. At best, these instruments are comparison devices because the human eye is incapable of measuring absolute quantities. Because of this, most laboratory photometric work today is done by physical measuring instruments, rather than by visual comparison processes.

(b) If the accuracy of visual measurements is to be better than ± ½ per cent, the radius of a disc source should not exceed 7/100 of the distance between the source and photometer head.[1] In other words, the cone described should have a total angle not greater than approximately eight degrees. (Generally, accuracies of ± two or three per cent are adequate.)

(c) The brightness of the photometric field has influence upon the sensitivity of the eye to small contrasts and, therefore, affects the precision of brightness measurements. For the highest accuracy of measurement, the brightness of the comparison field of a visual instrument should never be less than about one footlambert, and if possible, should be two or three times this value.[2] For good accuracy at extremely low levels, the eye should be adapted to the low levels.

(d) At brightness levels above one footlambert, it has been found that the luminous efficacy of visible radiant energy of different wavelengths is independent of the field brightness. However, this is not true for brightness levels below this value due to the Purkinje effect, in which the sensitivity of the eye to radiant energy shifts toward the shorter wavelengths or the blue end of the spectrum. This causes

the luminous efficacy of light sources to be different at scotopic, or low brightness levels, where rod vision is operative, than at the photopic, or high brightness levels, where cone vision is operative.[26] The Purkinje effect becomes of practical importance in the brightness measurement of streets and highways and luminescent materials.

(e) When measuring low level brightnesses, the eyes must be adapted to the level at which the measurements are to be made. At low brightnesses the pupil is enlarged and the retina increases in sensitivity. It is undesirable to use an artificial pupil smaller than the natural pupil, or an optical system which absorbs appreciable amounts of light. It is also very desirable that a reasonably good color match be present in any visual determination of low level brightness.

3.1.1—*Range of Commercially Available Instruments*—Range of instruments is covered in section 3.1.4 and manufacturers' data.

3.1.2—*Field of View*—The field of view varies from less than one degree to as much as three degrees depending upon the instrument used (see 3.1.4).

3.1.3—*Limitations — Accuracy, Color Differences*—**(a)** The accuracy of visual measurement of brightness for skilled operators is about ± two per cent for photopic measurements with comparison and test fields color matched. Accuracy of 10 to 20 per cent can be expected for measurements made in the scotopic range.[26]

(b) The eye tends to evaluate saturated colors as being brighter than less saturated colors when attempting to make a brightness match in a photometric field. If a filter which produces a match of spectral energy distribution is available, this situation is avoided and any abnormal color sensitivity of the observer is compensated for at the same time. Unfortunately, this ideal is not easily accomplished and a filter which produces the sensation of a color match rather than a spectral energy distribution match is resorted to in practice. This cannot compensate for all of the various types of abnormal color sensitivity found in visual type sof abnormal color sensitivity ual observers. Its use, however, will enable most observers to obtain more precise photometric balances. Since the comparison field in visual photometers is most often illuminated by an incandescent lamp, little trouble is experienced in measuring the photometric brightness of other surfaces illuminated by incandescent filament sources, while measurements of illumination produced by fluorescent lamps may prove troublesome. In many cases, brightness measured need not be determined with high accuracy, and errors due to lack of color match may be of no practical importance.

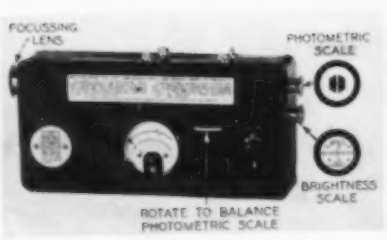

Figure 1. (left) The Luckiesh-Taylor Brightness Meter; (right) The Macbeth Illuminometer.

3.1.4—*Types of Visual Brightness Instruments*

3.1.4.1 — *Luckiesh-Taylor Brightness Meter*[5]—**(a)** This meter (see Fig. 1a) can be used to measure brightnesses throughout the range from .002 to 50,000 footlamberts. This range includes most of the brightnesses of importance in general lighting practice, except for the brighter light sources. The photographic gradient in this instrument is correct to ± 10 per cent. The optical system is such that an object one foot wide and seven feet long can be measured at a distance of 500 feet. Color correcting filters are not supplied with this instrument.

(b) The photometric comparison field and the test field are viewed by the observer through the upper small eyepiece. The comparison field consists of two small trapezoids illuminated by the lamp within the instrument. The test field is seen in the slit between the trapezoids, and in the space surrounding them, and may be brought into focus by an adjustable lens. The latter may also be used to throw the test surface out of focus if variations or texture make it difficult to determine the brightness balance point. Brightness of the comparison field is adjusted to balance with the test field by rotating a knurled disc, which carries the photographic gradient.

(c) Because of this gradient, there will be a difference in brightness in different parts of the comparison field (the trapezoids). Usually this variation is from top to bottom, parallel to the slit. Since it may be difficult to secure a balance of brightnesses throughout the entire field, it is well to remember that the original calibration balance is based on the center of the slit. Accordingly, in using this instrument, it is necessary to adjust for a brightness balance only between the line at the center representing the brightness being measured, and those portions of the trapezoids adjacent to this line.

(d) This instrument is no longer being manufactured.

3.1.4.2 — *Macbeth Illuminometer*[4] — **(a)** This instrument (see Fig. 1b) may be used for measuring brightness. It is usually calibrated with a particular test plate to read footcandles, but may be calibrated directly in footlamberts. If the former is the case, the values obtained must be multiplied by the reflectance of the test plate at the particular angle of observation used in the original calibration. The diameter of the observation field is roughly one-tenth of the distance between the observer and the surface being observed. At 30 feet, the diameter of the field is three feet (this is about three degrees although some Illuminometers have a field as small as two degrees). The range of the basic instrument is up to 25 footcandles but may be extended from 0.001 to 25,000 or more by the use of neutral filters.

(b) The characteristic of the eye related to the spectral luminous efficiency varies over the retinal surface. The concentric field normally supplied accentuates this unevenness and leads to incorrect results; the instrument has been supplied equipped wtih a split field, which permits both test and comparison brightnesses to illuminate the retina symmetrically, thus giving a correct result.

3.1.4.3—*The S.E.I.* Exposure Photometer*[5]—**(a)** This instrument may be

*Salford Electrical Instruments, Ltd.

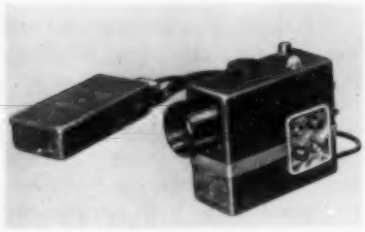

Figure 2. The Freund Spectra Brightness Spot Meter.

used for making brightness measurements. The equivalent angle of acceptance of the instrument is less than one degree. The accuracy of measurement is within ± 10 per cent. The weight is 1½ pounds. By means of range shift filters, the total range of the photometer is extended to 1,000,000 to 1. On looking through the eyepiece, a small portion of the object is visible. In the center of the field of view is a small mirror spot which is illuminated diffusely by the comparison lamp, the brightness of which is controlled by two opposed photometric wedges situated in the light path between the lamp and mirror. The novel feature of the instrument is the method of controlling the brightness of the comparison lamp.

(b) The light from the lamp falls on an annular photoelectric cell which is connected to a small microammeter. The fact that the actual light emitted by the lamp is used for calibration, instead of the current flowing through its filament, is said to be responsible for the accuracy of the photometer.

3.2—*Photoelectric Theory and Instruments*—(a) Since the spectral sensitivity of photocells does not change appreciably with illumination level, as does that of the eye, all measurements made in this manner are based upon the scale of photopic vision. Photocells may, however, be specially calibrated or filters obtained for use in the scotopic range of vision.[23, 24]

(b) The greatest advantage of using a barrier layer cell is that the spectral response curve of the cell can be acceptably corrected to the standard spectral luminous efficiency curve by the use of a filter. This is especially important when measuring gaseous discharge sources. There is no necessity for the illumination upon a photocell (assuming its sensitivity to be adequate) to be as high as one footcandle, and the distance from the diaphragmed area to be measured may be increased to an appropriate distance for satisfactory application of the inverse square law. For practical purposes, the inverse square law is satisfied when the test distance is at least five times the maximum dimension of the source being measured, the expected error being in the order of 0.6 per cent. (If the calibration of the measuring system is made under conditions of use, this error can be cancelled out.)

3.2.1—*Types of Photoelectric Brightness Meters*

3.2.1.1—*Freund Spectra Brightness Spot Meter*[6] — Two models of the Freund Spectra Brightness Spot Meter (see Fig. 2) are available. The *Standard Model* is available with a 1½-degree field with scale range of 1/10 to 100,000,000 footlamberts; also a ½-degree field with scale range of 1 to 1,000,000,000 footlamberts. The response is corrected approximately to the CIE spectral luminous efficiency curve. The instrument has a self-contained battery power supply. The instrument's accuracy is ± five per cent of the reading. In the *Ultra Sensitive Model*, the field sizes are the same as the Standard Model, but the scale ranges are 0.0001 to 10,000 footlamberts and 0.001 to 100,000 footlamberts. The accuracy is ± five per cent of the reading, and an external power supply is used. An attachment is available for measuring the brightness of areas as small as 0.015 inch in diameter.

3.2.1.2—*Barrier-Layer Cell Meter*—A brightness meter in which the foundation instrument is a pocket light meter composed of a spectrally uncorrected barrier layer cell, and microammeter, has been described.[7] Various sizes of shields were constructed which permitted light to reach the photocell through solid angles corresponding to a conical section with a plane angle of 5 to 50 degrees from the axis normal to the cell surface.

3.2.1.3—*Photoelectric Tube Meter*—A brightness instrument utilizing a phototube with an electronic amplifier using an electrometer tube has been described.[8] Its visual angle is one degree which approximates the angle subtended by the human fovea. The lower limit of measurement is about two footlamberts without a color-correcting filter. The response curve of the eye may be simulated by the use of proper Wratten filters. When using filters, the sensitivity of the instrument may be increased by the addition of another stage of amplification. The instrument is portable, but the search unit is separate from the amplifier and indicating instrument, the total weight being 10½ pounds.

4. Laboratory Measurements

4.1—*Sources*

4.1.1—*Incandescent*—**(a)** The brightness of incandescent sources, such as incandescent filament lamps, may be measured by three different methods.[9] The *first* is the direct method where the candlepower of a filament of known length and cross section or a definite area of a frosted bulb is measured and brightness calculated from these data.

(b) The *second* method is to measure the source brightness with a disappearing filament optical pyrometer.[10] This is the best method to use if the temperature of the filament is not uniform, or if the brightness of only a small portion of it is desired.

(c) The *third* method, applicable only to filaments of uniform brightness, makes use of the known brightness of a blackbody to compute the brightness.[11] (A coiled-coil filament is not of uniform brightness.)

4.1.2—*Carbon and Mercury Arcs*—**(a)** The brightness of carbon and mercury arcs may be measured by several methods depending upon the results that are wanted, *i.e.*, the average brightness of the whole source, or a portion, or its brightness distribution.

(b) Orange[12] has described a method of measuring the average brightness of arcs, in which two compound camera lenses equipped with iris diaphragms are employed, each of five-inch equivalent focal length. One compound lens is set up opposite the light source at a distance of about 15 inches. A photometer, either visual or physical, is arranged at about 30 inches from the second lens. The first lens casts an image of the source at the position of the diaphragm of the second lens; the second one casts an image of the first lens onto the plane of the photometer.

(c) The diaphragm of the first lens controls the definition of the source image, the one at the second lens permits selection of the extent of the source image or selection of its parts. Brightness is given by the equation:

$$B = \frac{Ex^2}{St\ 10{,}000} \text{ candelas per sq mm}$$

where E is the photometer reading in meter-candelas, x the distance of the second lens to the photometer in centimeters, S on the area of the opening of the second iris in square millimeters, and t the transmittance of the lens system.

(d) Another method of measuring average source brightness evolved in connection with the testing of searchlight carbons.[13] This method utilizes a system of lenses and mirrors and a visual photometer. An intergrating cube is also incorporated into the set-up for measuring the total flux from the arc.

(e) The measurement of brightness distribution of *arc sources* has been accomplished by *two* methods.

(f) In the first,[14] the light intensity of the projected image of the source is measured. A small lens of approximately seven-inch focal length is used to project the image of the crater or source. An ordinary barrier-layer cell, which is masked to ½-inch diameter corresponding to a ½-mm diameter at the source, is used. The brightness distribution is obtained by passing the photocell through the crater image.

(g) The *second* method presents a distribution of brightness on a cathode ray tube screen. The image produced by a lens is scanned by a rotating disc, the transmitted light falling upon an electron multiplier type of photocell. The signal is amplified and applied to the vertical deflection plates of the cathode ray tube, the time base being synchronized with the scanning base. The limiting sensitivity of this photometer is of the order of 0.3 candelas per square foot with the photocell spectrally uncorrected and 3.0 candelas per square foot with the cell corrected approximately to average eye response. A limitation of the photometer is that it measures instantaneous brightness, and if used with a source which varies periodically, such as electric discharge lamps, the trace on the cathode ray tube will also fluctuate.[15]

(h) A new instrument being developed will overcome this limitation.

4.1.3—*Fluorescent*—Prior to 1944, the brightness of fluorescent lamps was expressed as the maximum value at the center of and perpendicular to the lamp. Because of the small size of the area referred to, these values were not, in general, suitable for the calibration of brightness measuring instruments. Accordingly, a method of expressing brightness has been adopted,[16] in which the quantity is integrated across the lamp diameter at the center of the lamp. This brightness may be calculated as follows:

$$B_a \text{ (candelas per square inch)} = \frac{K \times \text{total lamp lumens}}{\text{lamp diameter} \times \text{lamp luminous length}}$$

where the diameter and length are expressed in inches and K is:

for 48-inch T-12 lamps $K = \dfrac{1.09}{9.25}$

72-inch T-12 lamps $K = \dfrac{1.07}{9.28}$

96-inch T-12 lamps $K = \dfrac{1.05}{9.28}$

4.2—*Luminaires* — Brightness measurements on luminaires may be made by either the *Absolute* or *Relative* methods.

4.2.1.—*General Lighting Luminaires*

(a) In the *Absolute* method any of the visual and photoelectric instruments having the proper range may be used. Reference standards must be available for instrument calibration. However, to place the results upon the basis of rated lamp lumens, the output of the test lamp must be known so that the brightness readings may be corrected to rated conditions. Also, it should be remembered that various instruments have different angular fields of view and the test distance must, therefore, be selected to suit the size of the area it is desired to measure.

(b) It also possible to mask out all of the luminaire except the area to be measured, and then determine the candlepower produced by this area with a portable illuminometer either of the visual or physical type.[17]

(c) Fluorescent luminaires lend themselves particularly well to the *Relative* method of brightness measurement since published lamp brightnesses are the quantity integrated across the entire lamp diameter and averaged over the center two-thirds of the lamp. It is, therefore, convenient to calibrate the brightness instrument from the brightness produced by the fluorescent lamps themselves.

(d) The published brightnesses of fluorescent lamps of nominally uniform radial distribution are computed from the rated lumen output of the lamp acording to the formula given in section 4.1.3.

(e) In the laboratory, an accurate means of establishing lamp brightness is accomplished by construction of a baffled tube two to three feet long,[18] with a receptor such as a photocell at one end, and at the other end, a rectangular aperture having one dimension equal to the lamp diameter, and the second dimension such that the product of the two dimensions equals one square inch. This tube is placed against the lamp near its midpoint so that the entire diameter of the lamp fills the aperture (the only time a one-inch by one-inch aperture may be used is when the lamp diameter is one inch such as for a T-8 lamp). The deflection of the indicating equipment is directly proportional to B_a. Deflections are noted at various spots within the middle two-thirds of the lamp, and then averaged. This average deflection represents a brightness corresponding to the lumen output of the lamp employed for the calibration. Other lamps of the same diameter can be read with this calibration, and comparisons of brightness derived, and their lumen outputs can be predicted within the accuracy of the published relationships. For the purpose of making brightness measurements on a luminaire *in which the above lamp is employed as a test lamp*, the average calibrating deflection can be assigned the brightness value of a lamp of rated lumens; any brightness measurement made with such a calibration will be correctly related to performance with lamps of rated output.

(f) For measuring brightness of a luminaire, an instrument having a circular aperture is preferable so that rotation of the instrument or angular position of luminaire will not affect readings. It is convenient, therefore, to use another collimating tube with an aperture of 1⅛ inches in diameter, or brightness meters with circular fields of view, encompassing one square inch at the measuring distance, and calibrated against a "working standard" which can be similar to the device shown in Fig. 3. In use, the diffusing face is adjusted in relation to the source such that the deflection of the indicating instrument using a rectangular aperture is the same as was indicated when the aperture was placed against the reference fluorescent lamp. The circular aperture and collimator is then substituted and the deflection noted. This will be the deflection for the lamp brightness. All luminaire brightness

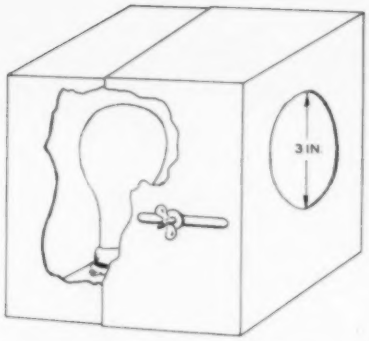

Figure 3. An adjustable source of brightness useful when calibrating brightness measuring devices.

readings made with this circular aperture are then directly related.

(g) Experimentation has shown that if a one-inch by one-inch aperture is used for calibrating the brightness instrument for a T-12 lamp, the luminaire brightness reading may be too low by as much as 20 per cent, the error depending on the manner of calibration, length of collimating tube, etc.

(h) The brightness instrument calibration should be made from the bare fluorescent lamps burning in air and energized from the same ballast used when the luminaire brightness readings are made. Care should be taken to eliminate interflections between lamps, however, by inserting matte black baffles between lamps. This type of brightness instrument may also be calibrated in absolute units by illuminating a small diffuse surface of known reflectance with a horizontal candlepower standard lamp.

(i) The average brightness of general lighting luminaires may be computed from the candlepower divided by the projected area in the direction of view in question. The area to be included in this computation would be all luminous areas of the luminaire plus those nonluminous areas which would be illuminated *appreciably* by reflected light in normal installation. (For example, high reflectance metal sides of a unit with at least 15 per cent of its output in the 110- to 140-degree zone would be included in the projected luminous area.)[32]

(j) For surface mounted luminaires, the area of the simulated ceiling as recommended in the IES Guide for Photometric Testing of Fluorescent Luminaires,* should also be included as part of the projected area in the direction of view.

4.2.2—*Close-to-Ceiling Mounted Luminaires*—In calculating the projected area of luminaires having a mounting position of six inches or less from the top of the luminaire to the ceiling, and which without ceiling mounting deliver 25 per cent or more of their light in the 90- to 180-degree zone, the projection of a ceiling area of luminaire length and of a "Y" width should be included in the luminaire projected area provided the reflectance of the ceiling is 80 ± 15 per cent.** The "Y" width is the vertical projection of the luminaire upon the ceiling. (See Fig. 4.)

*In preparation.

**In calculating projected area for luminaires which are surface-mounted tightly against the ceiling so that the upward light is not visible on the ceiling, neither opaque side panels nor the "Y" dimension on the ceiling should be included. For luminaires of circular design the "Y" dimension should be considered to be diameters of circles.

The average brightness calculations should be based upon the candlepower obtained from the combination of luminaire and simulated ceiling having an 80 ± 3 per cent matte white reflectance (see Guide for Photometric Testing of Fluorescent Luminaires*).

4.3—*Measurements of Surface Brightnesses*

4.3.1—*Bright Transmitting Surfaces*—In the case of bright transmitting surfaces, the brightness may be measured by placing the aperture of the instrument in contact with the surface. Care should be taken that interreflections contributing to the surface brightness are not blocked or increased by the measuring instrument.

4.3.2—*Bright Reflecting Surfaces*—In the case of bright reflecting surfaces, the aperture of the instrument must be far enough away from the surface so as not to block the incident light producing the brightness. The actual area viewed will then be a function of the instrument's collimating properties.

5. Field Measurements

(a) In making field measurements, the following precautions should be taken. If there is a background brightness along with the brightness to be measured, both within the field of view of the instrument, an arithmetical correction should be made to the reading. Also, if the brightness being measured is without extended background brightness and does not completely fill the field of view, a correction should be made.

(b) A color-corrected measuring device should be used in making field

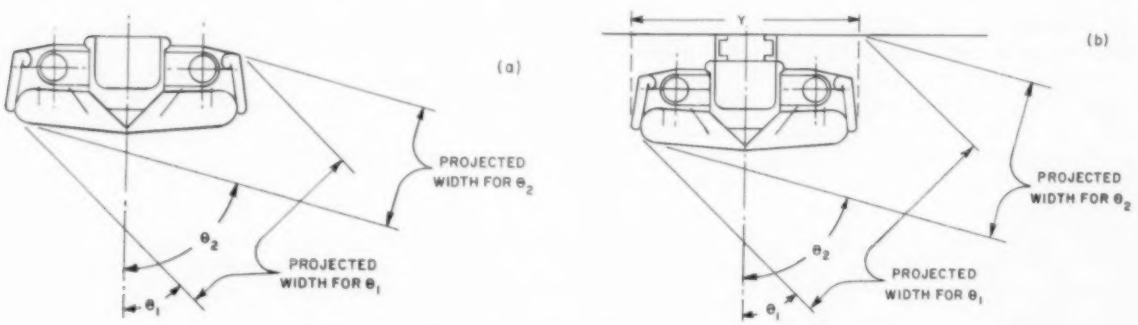

Figure 4. Projected widths for use in calculating projected area for the average brightness calculations. (a) For all mounting except close to the ceiling mounting. (b) For close to the ceiling mounting. Crosswise projected area is length times projected width. Endwise projected area is width times projected length or width times length times cos θ.

measurements of brightness such as walls, ceilings, floors and desks. Color differences between the measured surface and comparison source can render a visual instrument much less accurate than a photoelectric type.

(c) Reflectance of surfaces, such as walls, ceilings, floors and desks may be readily measured with portable instruments similar to the Luckiesh-Taylor Brightness Meter or Freund Spectra Brightness Spot Meter, using a magnesium oxide or magnesium carbonate disc. The disc should be held adjacent to the area to be measured, noting the brightness readings of each. The reading on the disc should be taken outside the 30-degree cone centered along the direction of mirror reflection from any source of direct illumination. The disc may then be considered as 100 per cent. (This is not exactly correct because magnesium oxide has a reflectance of 98 per cent, and magnesium carbonate has a reflectance of 96 per cent.) The reflectance of the unknown surface is obtained by dividing its brightness reading by the disc reading.

6. Miscellaneous Brightness Measurements

6.1—*Extended Areas*—The brightness of different parts of an extended area, such as a street surface, is most conveniently found by photographing the scene together with a series of surfaces having a range of known brightnesses in order to establish a scale relating density to brightness. A densitometer is then used to measure the density of different parts of the photographic negative.[19] Care should be taken that the exposure be such that the density of the negative is on the straight portion of the exposure-density curve.[22]

6.2—*Weak or Small Sources*—

(a) It may be impractical to measure the brightness of *very weak* or *very small* sources by ordinary methods. In this case, it may be convenient to use an instrument incorporating the Maxwellian view.[20]

(b) An image of the source is formed on the pupil of the observer's eye by means of a lens which consequently appears bright over its entire surface. The lens occupies one half of the photometric field, and the other half is occupied by a mirror which reflects to the eye the light from a piece of uniformly bright opal glass. The comparison source illuminates the opal glass, and the photometric balance between the two fields is made by varying the distance of the comparison source.

(c) In measuring extremely low brightnesses, peripheral vision is more accurate than cone or macula vision. In these cases, more consistent measurements may be made by observing a fixation point approximately four degrees removed from the standard and test surfaces.

6.3—The closest approach to an ideal visual brightness instrument is one developed by Norton.[21] A glass plate which acts as a beam-splitter is inclined at 45 degrees to the direction of view. This glass plate reflects light from the comparison lamp into the field of view. The plate is made of light smoked glass so that there are two reflected images of the comparison source of unequal brightness. The brightness of the comparison lamp is then varied until one of the reflected images is visible and the other invisible against the field. The quantity actually measured is the adaptation level of the observer, and care must be taken to exclude stray light from the eyes.

7. Recommendation for Unification of Measurement and Reporting Brightness

(a) Physical measurements, where practical, should be made in preference to visual measurements.

(b) When barrier-layer cells are used, the cells should possess a spectral response curve as close as practical to the standard spectral luminous efficiency curve. (Hermetically sealed cells are a definite asset for all around work.)

(c) Reports containing brightness data should state means of calibration (absolute or relative), and area measured (in one inch square, one circular square inch, or size of rectangular aperture). It is also recommended that both maximum and average brightness data be reported for general lighting luminaires.

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INSTALLATION AT AUBREY'S 1000 ISLAND BOWLING CENTER, CLAYTON, N. Y.

Lighting a Bowling Center

LIGHTING OBJECTIVE: To provide general illumination and a comfortable environment for bowling.

GENERAL INFORMATION: The lower portions of the saw-tooth ceiling in this 12-lane, 74-foot wide bowling center are approximately nine feet above the alley floor, while the higher portions are approximately 11 feet above the floor. The distance between lower portions is 20 feet, making the total length of saw-tooth ceiling above each alley about 60 feet. Colors and reflectances of the major room surfaces are: ceiling, white (80% RF); walls, cream (70% RF); pin-setting machine, green (17% RF); floor, maple (50% RF).

INSTALLATION: General lane illumination is provided by Keystone Electric Mfg. Co. catalog No. CH296PG-16 fluorescent channels, equipped with two 96-inch PG-17 cool white lamps. There are eight of these units installed and concealed from player's view in each of the vertical portions of the saw-tooth ceiling construction. The general horizontal level of illumination varies from 70 to 155 footcandles along each lane. A level of 250 footcandles, vertical, is provided at the "one" pins with the addition of single-lamp fluorescent units, one per lane, mounted directly over the pin setters. Lamps used are 40-watt T-12 cool white. Brightnesses at the time of illumination measurements were: higher portion of ceiling, 70 fL; lower portion of ceiling, 25 fL; walls, 40 fL; floor, 34 fL.

Lighting designed by Carl B. Martin, Jr., Niagara Mohawk Power Corp., Watertown, N. Y.

Lighting data submitted by Carl B. Martin, Jr., and Carleton L. Peckham, Niagara Mohawk Power Corp., Syracuse, N. Y. as an illustration of good lighting practice and to aid in the design of similar installations.

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Here and There with IES Members

Displaying Applied Lighting Competition award certificates are Alabama Section members Charlton B. McArthur (right) and Harry Dorman. Mr. McArthur was awarded first prize in the Alabama Section and third prize in the South Central Region for his lighting of the Thomas Jefferson Hotel. Mr. Dorman won second prize in the Alabama Section for his bowling center installation.

IES Fellow, Oscar P. Cleaver (right), chief of the electrical department, U. S. Army Engineer Research and Development Laboratories, Ft. Belvoir, Va., receives his ninth "outstanding" rating certificate from laboratory director, Col. J. H. Kerkering. Mr. Cleaver, holder of several "sustained superior performance" awards, has received more performance citations than any laboratory employee.

Participants in the Housatonic Chapter's Applied Lighting Competition program, l. to r.: Walter Damuck, Chapter Chairman; Charles Newman, ALC Chairman; Michael Powell, contestant; S. R. Shemitz, first, Class I—Residential; Frank LaGuisa, second, Class I; John Northrup, first, Class II — Commercial; C. W. McCormick, John Shallenberger and Edward Rambusch, judges.

Incoming and outgoing Iowa Section officers, shown here at the Section's summer conference on industrial lighting, include, left to right: Harvey Taylor, incoming vice-chairman; Lou Kingsley, outgoing chairman; Leonard De Hoet, incoming board of managers; Arne Oja, incoming chairman; Richard Gruhl, outgoing board of managers; E. H. Ford, incoming secretary-treasurer.

Winners of Allied Arts contest at University of New Mexico, shown here with Carl Albach (second from left), Allied Arts Chairman, New Mexico Chapter, were, left to right: William Gonzales, second prize; Robert Maraga, first prize, and Anthony Bloch, third prize: Competition problem was the architectural and lighting design for a remodelled coffee house and bookstore.

LIGHTING NEWS

Office Lighting Campaign Announced At Midwest Electric/Lighting Show

The Electric Association of Chicago and the Chicago Lighting Institute announced the organization of a joint committee for the promotion of IES recommended office lighting levels in the Chicago area. Details of the program were presented to a group of 300 contractors, distributors and manufacturers at the kick-off luncheon of the sixth biennial Midwest Electrical Industry and Lighting Exposition, held May 2-4, at McCormick Place in Chicago. James F. Whitehead, Jr., president of Day-Brite Lighting, Inc., St. Louis, Mo., delivered the keynote address at the luncheon.

The committee's program for the office lighting promotion campaign includes the development of a six-session course on the fundamentals of illumination and a series of advertising and promotion aids. Two courses have already been conducted in Chicago, and a full schedule is planned for the entire area this fall.

Although the committee's initial efforts are being directed toward the improvement of office lighting conditions, long-range plans include the promotion of industrial, store and outdoor lighting.

The Midwest Exposition (formerly called the Chicago Electrical Industry Show) attracted a total of 10,000 visitors from a five-state area. Over 250 exhibit booths featured lighting equipment, electrical construction materials, space heating equipment, control devices, communications equipment, tools and industrial apparatus and electronic equipment. The lighting exhibits, which emphasized office lighting products, were supplemented by educational displays on office lighting manned by the Chicago Lighting Institute and the joint promotion committee.

C. C. Simpson, managing director of the Electric Association of Chicago, served as exposition manager; J. M. Wolfe, Westinghouse Electric Corp., was chairman of the exposition committee.

Connecticut Fundamentals Course Results in 33 New IES Members

In addition to their educational function, Section/Chapter lighting courses can be a fruitful source of new members, if the Connecticut Section's experience is an indication. Thirty-three of the 73 nonmembers registered in the Section's first fundamentals of illumination course are now members of IES.

The course had an enrollment of 83, including salesmen for electrical supply companies, manufacturers and utilities (40 per cent); design and specification engineers from architectural and consulting engineering firms and municipal engineering agencies (35 per cent); electrical maintenance employees of large manufacturing companies (15 per cent) and employees of electrical maintenance firms (10 per cent). The course was conducted in eight sessions, with 77 of the students attending at least seven times. Twenty-three prospective students who could not be accommodated for this year's course will form the nucleus of the 1962 class.

G. W. Beals, chairman of the Connecticut Section's Education Committee, served as coordinator of the course. Instructors included Willard Allphin, Sylvania Lighting Products, Salem, Mass.; L. S. Cooke, General Electric Co., Boston, Mass.; George Bishop, Holophane Co., Inc.; Theodore Ake, Jr. and John J. Neidhart, The Miller Co., Meriden, Conn.; Court Johannsen, Day-Brite

PLANS for the promotion of better office lighting in the Chicago area were announced to a group of 300 representatives of the electrical industry at a luncheon (above) held in conjunction with the Midwest Electrical Industry and Lighting Exposition, May 2-4. The program will be conducted jointly by the Chicago Lighting Institute and the Electrical Association of Chicago. Photo at right shows the exhibit floor at the exposition.

MEMBERS of the IES Aviation Committee gather for a tour of lighting and landing aids at Andrews Field, during their semi-annual meeting, held May 4-5 in Washington, D. C. On platform at left are Lt. Col. H. G. Howton (in uniform) and G. K. Clement, U. S. Air Force Headquarters.

Lighting, Inc., Branford, Conn.; Alfred Makulec, General Electric Co., Cleveland, Ohio; J. R. Bale, Westinghouse Electric Corp., Cleveland, Ohio; and Francis Clark, Lighting Services, Inc., Westbury, Conn.

Semi-Annual Aviation Meeting Held in Washington, D. C.

A full technical program on the latest developments in aviation lighting plus a tour of the landing aids and lighting facilities at Andrews Field highlighted the semi-annual meeting of the IES Aviation Lighting Committee, held May 4-5 in Washington, D. C. Approximately 90 members and guests were in attendance at the meeting.

Featured on the papers program was a report by E. W. Estelle, Weather Bureau meteorologist, and William Eggert, Federal Aviation Agency Experimental Facility, on the new method of classifying weather at an airport in terms of Runway Visual Range (RVR) and Approach Light Contact Height (ALCH). These are new terms where photometric measuring equipment is used as a basis for advising an incoming pilot where he can expect to break out of the overcast and see the lights. Other presentations included a report on the measurements of the brightness of fog when illuminated by approach and runway lights, by J. W. Simeroth, National Bureau of Standards Station, Arcata, Calif., and three papers on the current subject of "flush" lights embedded in the pavement in runway touchdown area and centerline by G. K. Clement, Air Force Headquarters; L. C. Vipond, F.A.A. Research and Development; and R. D. Hartz, Bureau of Naval Weapons.

Aircraft lighting papers included a study of temperatures in the neighborhood of 500°F to 800°F encountered with MACH 3 planes and the optical design of very compact navigation lights for thin wing and tail sections by G. W. Godfrey, North American Aviation; new principles of edge-lighting for instruments and displays by G. W. Hardesty, Naval Experiment Station; and the problems of exterior lighting for collision avoidance, J. E. Robinson, Applied Psychology Corp.

The tour of Andrews Field, which the Air Force plans to maintain as its most advanced installation of landing aids and lighting, was conducted under the direction of Lt. Col. Harry G. Howton.

Street Lighting Contest Awards Increased by Reader's Digest

To encourage citizen participation in the promotion of better street and highway lighting throughout the United States, *Reader's Digest* magazine has announced an increase in the number of awards in its street lighting contest for the General Federation of Women's Clubs. Sixty awards will be conferred in 1962, as compared with six in 1961.

The contest was established by the magazine last year, after its investigation of the claims of an article, "To Make Streets Safe After Dark," indicated the urgent need for adequate lighting for the prevention of crime after dark and reduction of street and highway accidents. First prize of $500 in the 1961 contest was awarded to the Woman's Club of Newport, Minn. Awards of $100 each were made to the Woman's Clubs of Land O' Lakes, Fla., Verona, Pa., West Columbia, S. C., Bozeman, Mont., and West Haven, Conn., in recognition of their efforts in the promo-

(Continued on page 13A)

PHOTOGRAPH of the 1930 IES National Technical Conference in Richmond, the first commercial photo taken with the flash bulb, is being shown by photographer A. L. Dementi (right) to his son R. A. Dementi. Mr. Dementi, Sr., who took the picture of the IES meeting using 24 lamps fired simultaneously, is also holding one of the early flash bulbs. The father and son photographer team recently lectured at a meeting of the Richmond Camera Club on the developments in photography from the first aluminum "foil" type flash bulbs and present-day electronic flash equipment.

that helps VHO fluorescent keep on giving more light

Only Sylvania VHO Powertubes give you the profile and the policy that guarantee more light – or your money back!

Within a year dust can black out *20% or more* of the light you pay for. That's why Sylvania VHO (Very High Output) Powertubes are made round and smooth. Their simple tubular design sheds dust, and wipes clean with just a stroke.

But even more, it's the superior combination of new Sylvania phosphors and gases *inside* that enables this tube–only 1½" in diameter – to deliver the brightest light of all Sylvania fluorescents.

Because they're of the familiar standard weight, no oversize fixtures are needed for VHO Powertubes. And you get 2½ times more light than from standard fluorescents!

No wonder Sylvania can offer this *exclusive* money-back guarantee: If at any time a Sylvania Fluorescent Lamp fails in your opinion to provide better performance than any other brand fluorescent lamps, on the basis of uniformity of performance, uniformity of appearance, maintained brightness and life, it may be returned to the supplier for full refund of purchase price.

Get the straight story on light. Call your Sylvania representative. Or write: Lighting Division, Sylvania Electric Products Inc., Dept. 617, 60 Boston St., Salem, Mass. In Canada: Sylvania Electric (Canada) Ltd., Montreal.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

POWER TO SPARE

Steel City Channel MOUNTS-
FOR SURFACE

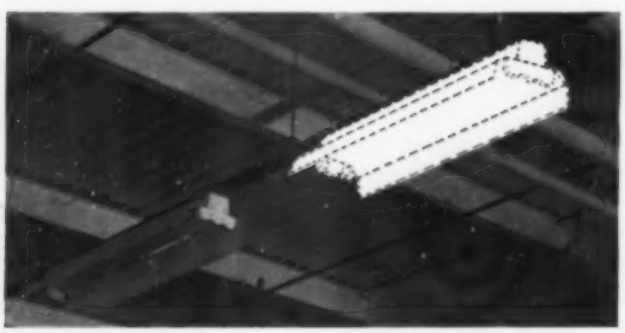
POWER TO SPARE—

A central wiring distribution channel with conductor capacity that exceeds requirements of any lighting layout and with power to spare for other uses. Here's a Channel that adapts to any interval of structural support—may be dropped to any level where it becomes a rigid platform for fixture attachment. Lighting fixtures may be spaced and fastened anywhere along the Channel System.

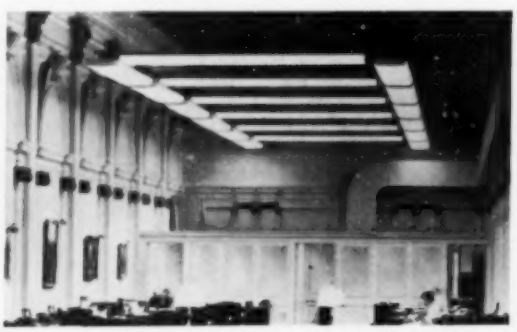
Branch lighting circuit conductors are completely enclosed in Channel from panel to fixture. This raceway carries full Underwriters' Laboratories, Inc. approval.

MONEY-SAVING FEATURES . . .

● Eliminates Conduit Runs. Eliminates cutting and threading of conduits for stems ● Uses existing boxes for wiring feeds. Simplifies repair of ballasts ● Easy removal of fixture for cleaning reduces maintenance costs ● Plug in method reduces wiring costs.



The continuous slot Channel provides complete flexibility of lighting layout. Fixtures may be added or relocated as required. Maintenance costs are reduced by simplified fixture removal . . . merely un-plug cord, open sliding fixture hangers and lower fixture. It's that easy.

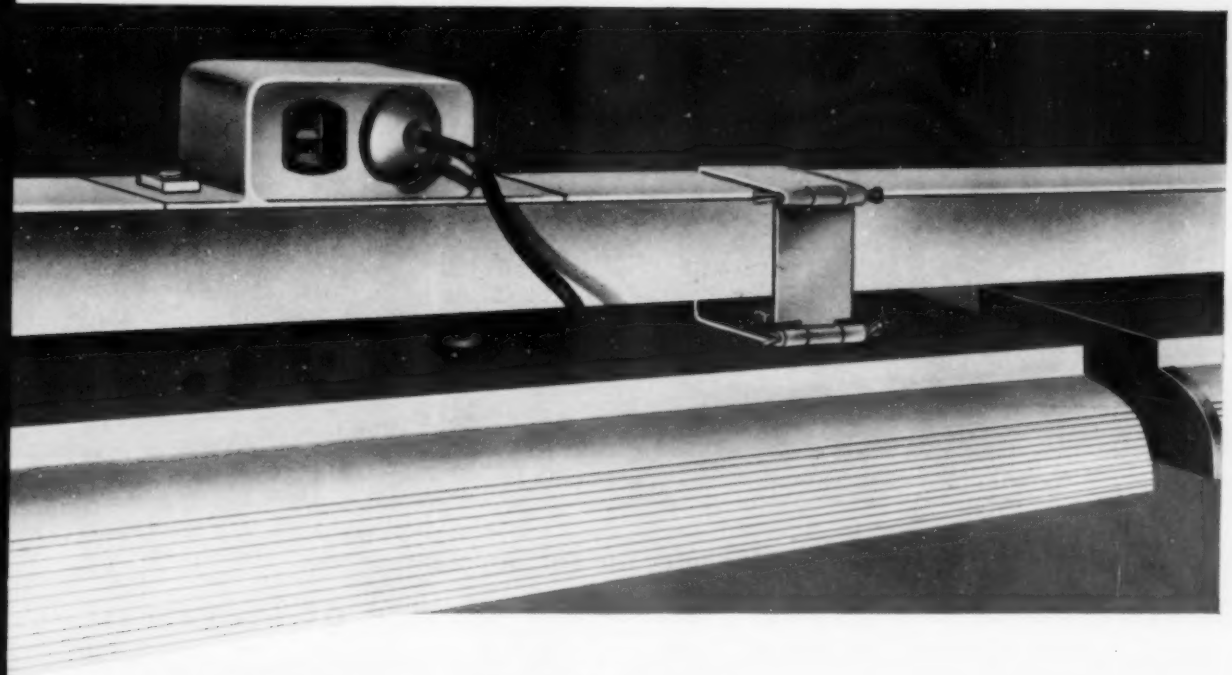


Steel City Channel mounts, hangs and feeds the fluorescent fixtures in the lighting modernization of a bank office.

STEEL CITY ELECTRIC COMPANY

A subsidiary of American-Marietta Company

PITTSBURGH 33, PA.



HANGS & FEEDS the fixtures

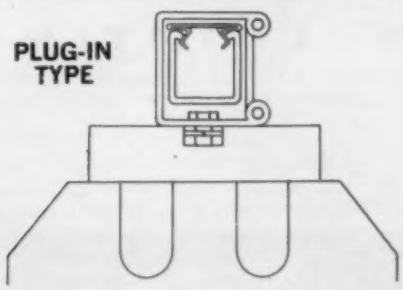
OR SUSPENDED LIGHTING

SURFACE RACEWAY SYSTEMS

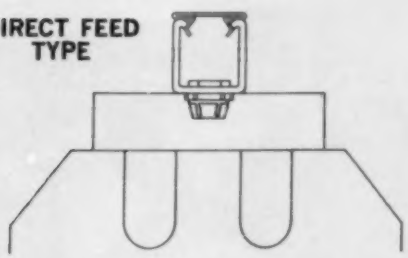
LISTED BY UNDERWRITERS' LABORATORIES, INC.

FIXTURE ATTACHMENT METHODS

PLUG-IN TYPE



DIRECT FEED TYPE



STEEL CITY CHANNELS

Channels of various depths and gauges, for use as surface raceway wiring systems or for fixture support only, are available as standard.

When used as a raceway, the Channel capacities are more than ample for every lighting requirement—up to ten No. 8 AWG conductors (National Electrical Code).

Steel City Channels and accessory fittings are protected by the GALV-KROM finish—an electrogalvanized finish PLUS added protection of zinc chromate. The GALV-KROM process imparts an attractive bronze lustre to the surface which does not require painting.

Steel City Electric Co.
Pittsburgh 33, Pa.

Please send me free booklet G-2.

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Company_____

Address_____

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Careful attention to design and construction refinements characterize Revere's standard line. These same skills help answer the unusual equipment needs brought to Revere by volume users of specialized outdoor lighting products.

What makes Revere the consultant's choice for outdoor lighting?

Revere capacity gives you wider choice of standard equipment and excellent service on custom designs

You can solve the vast majority of outdoor lighting problems with the wide line of standard equipment listed in Revere's catalog. And for unusual application requirements, you can get prompt service on custom-engineered equipment or modifications of our standard designs.

Revere's high-volume production capacity and large inventory account for the great selection of equipment available for immediate delivery. Special facilities account for fast service on custom equipment available in production quantities for volume users. And Revere's policy of designing *up* to a performance level, never down to a price level gives users all the light they pay for in fixtures that outlast even their own expectations.

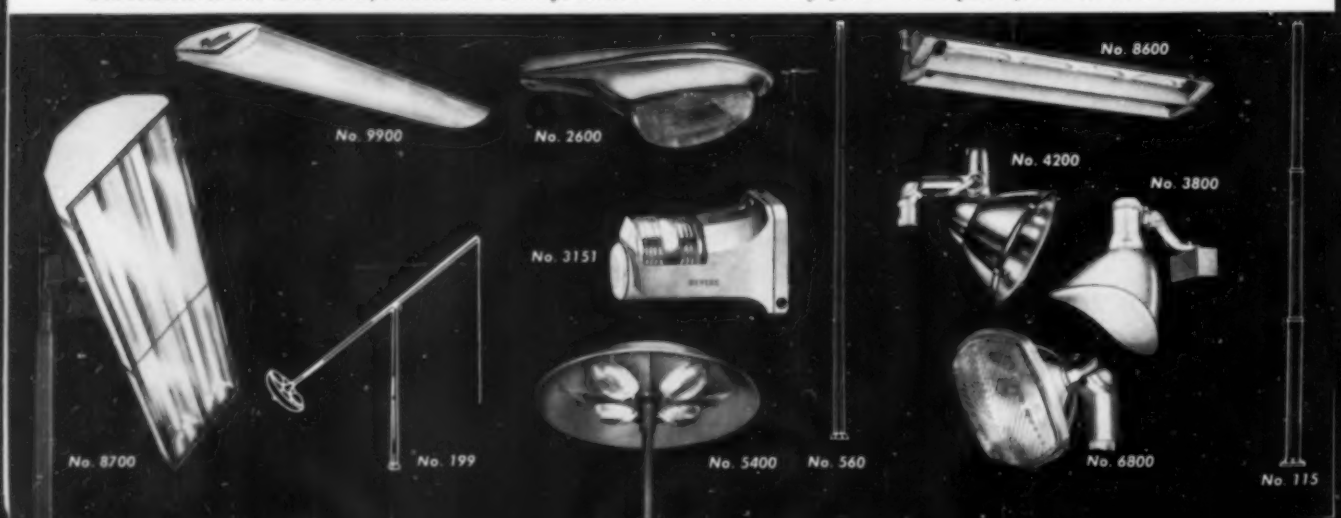
Revere offers consulting engineers and their clients the industry's widest line of outdoor fluorescent, incandescent and mercury luminaires as well as poles and accessories — *design* matched for best appearance and peak lighting efficiency, and *structurally* matched for strength, balance and trouble-free installation. For complete descriptive and technical data, write for your copy of Revere's comprehensive outdoor lighting catalog. For information on custom engineered lighting equipment, feel free to consult your Revere sales engineer. He can show why Revere is the consultant's choice.

Revere ELECTRIC MFG. CO.

OUTDOOR LIGHTING

Revere Electric Mfg. Co. • 7420 Lehigh Avenue • Chicago 48, Illinois (In suburban Niles)
Long Distance Phone: NI les 7-6060 • Chicago Phone: SPring 4-1200 • Telegrams: WUX Niles

Selecting everything you need in outdoor lighting from one reliable source saves time, trouble and money. Shown are just a few representative fluorescent, incandescent and mercury fixtures and poles from Revere's wide line.



(Continued from page 8A)

tion of better street and highway lighting in their communities.

Jury of Awards for the contest was composed of: Chairman, Mrs. W. G. Teare, president, Lakewood School Board; Michael Blackwell, Cleveland Police Department; V. L. Johnson, traffic engineer, Cleveland Safety Council; J. R. Smith, general manager, Yellow Cab Co.; G. S. Livingston, Welfare Federation of Cleveland. Edmond C. Power, educational director of the Street and Highway Safety Lighting Bureau, served as special consultant to the jury.

Hollywood Lighting Exposition Scheduled for October 3-5

The first Lighting Progress Exposition sponsored by the Electrical League of Southern California will be held at the Hollywood Palladium, Hollywood, Calif., October 3-5, 1961. Invitations to the exposition, which will be restricted to the trade, are being sent to 20,000 architects, builders, contractors, decorators, consulting and maintenance engineers and electrical wholesalers.

In conjunction with the exhibitions of industrial, commercial and residential lighting equipment, there will be a series of symposiums on all phases of lighting application. Details of the program, which is being planned under the direction of IES South Pacific Coast Regional V-P, Roy Kreyser, Los Angeles Department of Water and Power, and Roy Dahlin, Southern California Edison Co., will be announced soon.

Further details on the exposition may be obtained from A. Howard Williams, Exposition Manager, 2140 Westwood Blvd., Los Angeles 25, Calif.

Floodlighting Institute Announces Availability of Promotion Kit

The Floodlighting Institute, established last March for the dissemination of information on modern floodlighting practice, has announced the availability of a floodlighting promotion kit. Included in the kit are three 8½- by 11-inch brochures covering floodlighting of churches, monuments and landmarks, public, civic and industrial buildings; self-mailers for each of these application areas; a reprint of the architectural floodlighting section of the *IES Lighting Handbook*, Third Edition; and a booklet discussing techniques for the promotion of floodlighting. Not included in the kit, but available for promotion programs at a cost of $75, are sets of film slides, 20 slides per set.

Cost of the complete promotion kit, not

(Continued on page 16A)

SCHEDULED EVENTS

1961 Dates of Interest to IES Members

July

July 18-20—Western Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif.

August

August 21-23—National Association of Lighting Maintenance Contractors, National Convention, Flamingo Hotel, Las Vegas, Nev.

August 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco, Calif.

August 23-25—American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Utah.

September

September 12-15—Industrial Building Exposition, New York City Coliseum, New York, N. Y.

September 14-15—Engineering Management Meeting, sponsored by AIEE and ASME, Hotel Roosevelt, New York, N. Y.

September 24-29—Illuminating Engineering Society, National Technical Conference, Chase-Park Plaza Hotel, St. Louis, Mo.

October

October 1-6—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Lake Placid Club, Lake Placid, N. Y.

October 3-5—Lighting Progress Exposition, sponsored by Electrical League of Southern California, Hollywood Palladium, Hollywood, Calif.

October 3-5—Delaware Valley Electrical Progress Show, Convention Hall, Philadelphia, Pa.

October 4-6—Canadian Electrical Manufacturers Association, Annual Meeting, Sheraton-Brock Hotel, Niagara Falls, Ont.

October 4-6—International Association of Electrical Leagues, Annual Conference, President Hotel, Atlantic City, N. J.

October 9-10—United States National Committe, CIE, Annual Meeting, Olentangy Inn, Columbus, Ohio.

October 9-11—Annual National Electronics Conference, International Amphitheatre, Chicago, Ill.

October 10-12—American Standards Association, National Conference on Standards, Rice Hotel, Houston, Texas.

October 10-13—National Electrical Contractors Association, Annual Convention and Exposition, Washington, D. C.

October 15-20—American Institute of Electrical Engineers, Fall General Meeting, Detroit, Mich.

October 18-20—Optical Society of America, Annual Meeting, Biltmore Hotel, Los Angeles, Calif.

November

November 6-8—National Warm Air Heating and Air Conditioning Association, Annual Convention, LaSalle Hotel, Chicago, Ill.

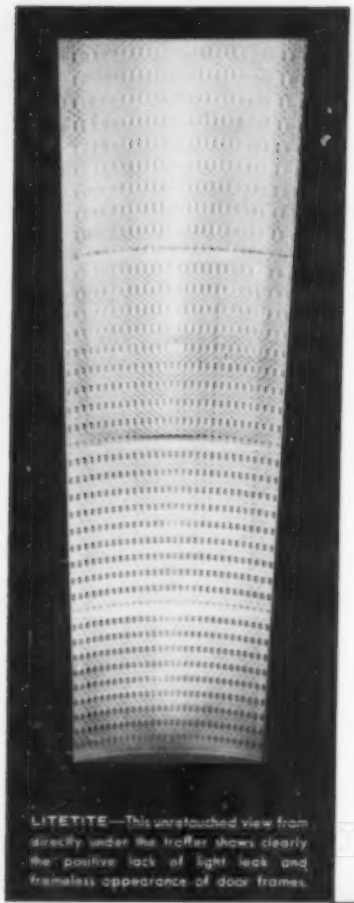
November 16—National Electrical Manufacturers Association, Annual Meeting, Summit Hotel, New York, N. Y.

November 24-29—1961 Electrical and Home Appliance Show, Electric Building, Balboa Park, San Diego, Calif.

IES Headquarters Moves To New Address September 1, 1961

After September 1st, when IES Headquarters moves into the new United Engineering Center, its address will be:

Illuminating Engineering Society
345 East 47th Street
at United Nations Plaza
New York 17, N. Y.



LITETITE—This unretouched view from directly under the troffer shows clearly the positive lack of light leak and frameless appearance of door frames.

Presenting

A NEW LITECONTROL TROFFER LINE

SERIES 9300RS, 9400RS.

NEW LITECONTROL TROFFERS LIGHTEN TASKS AT THESE BUILDINGS

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Reservoir Power Plant — also,
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Space Science Building
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GENESEE HOSPITAL
Rochester, New York

LINCOLN HIGH SCHOOL
Manitowoc, Wisconsin

NEW ENGLAND TELEPHONE & TELEGRAPH CO.
Boston, Massachusetts

NEW OSTEOPATHIC HOSPITAL
York, Pennsylvania

AMERICAN OPTICAL COMPANY
Southbridge, Massachusetts

EASTERN STATES COLLEGE
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Consider these outstanding features:

Style plus Quality: The simple good looks of these troffers blend well into any type of interior. Narrow unobtrusive flanges. Very limited metal shows on door frame giving frameless appearance. 1′ x 4′ troffers show unbroken line of light in rows. Fixtures are die-formed, welded, rust-resistant, and finished baked white enamel with 0.89 reflectance.

Variety of Design: 194 different troffers shown in Litecontrol catalog. For modular applications — 1′ x 2′, 1′ x 4′, 1′ x 8′, 2′ x 2′, 2′ x 4 and 4′ x 4′ sizes. Refer to sections B and F in catalog for more detailed information.

Easily Installed: Two basic housing designs will fit into every type of ceiling construction. Shallow ($4\frac{15}{16}''$) housing and side-mounted, easily adjustable brackets make fixtures a snap to install.

Easily Serviced: Die-formed Lite-Tite door eliminates catches and exposed hinges. Door operates at fingertip touch. All diffusers are interchangeable in the same door. Diffusers include: Holophane lenses #6250, #6150, #6025, #6010, #9022. Plexiglas Dish. Corning #70 Lens Panel. Corning Radiated-Radio-Interference Shielding #EC-70 Lens Panel. Plastic Grid Louvers. STYLUX Plastic Panel. Fiberglas Panel.

We suggest the efficient, modular design of Litecontrol Troffers can fulfill your needs in present or future specifications. For further information, please write address below.

NEW! with Holophane No. 6250 Lens

9500RS AND 9600RS

Fingertip operation: To close, push door into far side of housing, lift in and let drop into place. Door opens for servicing *just as easily* because there's no latch to catch.

Large Massachusetts department store chooses quality lighting, using Litecontrol #9400 series troffers with plastic grid louvers providing comfortable high level illumination for shoppers.

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LIGHTING
LITECONTROL CORPORATION,
36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

ARTIST's conception of the 24-billion candlepower "tower of light" which is being planned as part of the electric utility companies' exhibit at the 1964-1965 New York World's Fair. Design was announced at the 29th Annual Convention of the Edison Electric Institute, held recently in New York City.

(Continued from page 13A)

including slides, is $5. A price list for each of the individual items is included in the kit. Kits and complete information on the Institute's program are available from Floodlighting Institute, 55 Public Square, Cleveland 13, Ohio.

Daylighting Measurements Subject of British Report

Standardization of daylighting measurements in types of measurements made, instrumental techniques employed, and presentation of data are the subject of a recent report made for the Daylight Sub-Committee of the National Illumination Committee of Great Britain. An article based on the report, which was compiled by a panel composed of R. H. Collingbourne, Kew Observatory, Richmond, Surrey; P. Pethebridge, Building Research Station, Watford, Herts; and G. Spur, Central Electricity Research Laboratories, Leatherhead, Surrey, was published in the March 1961 issue of *Light and Lighting*.

The report offers five types of daylighting measurements for which some degree of standardization would be required: (1) total (sun and sky) and diffuse (sky) illumination on an unobstructed horizontal surface; (2) direct solar illumination; (3) luminous efficiency of natural daylight; (4) sky luminance distribution; (5) spectral composition of sun and sky radiation. The report recommends that appropriate recordings be made so that these measurements can, if required, be correlated with cloud coverage, duration of sunshine and position of the sun (particularly solar altitude).

No specific recommendations are made with respect to measurements of vertical surface illumination.

Techniques of daylighting measurement are discussed with particular reference to the color and "cosine" responses of the light receptors and their sensitivity to temperature and humidity changes. Calibration of measuring equipment and present-day techniques for data recording are also covered. The final section of the report deals with methods for presenting illumination data, luminous efficiency values and sky luminance distributions. The photometric units, metric or nonmetric, to be adopted will depend upon the use to be made of the data.

"Tower of Light" Planned for Power-Light Exhibit at N. Y. Fair

A 24-billion candlepower tower of light, expected to be visible from as far away as Boston, Mass., and Washington, D. C., is being planned as a highlight of the electric utility companies' exhibit at the 1964-1965 New York World's Fair. Described as the "greatest concentration of light ever generated," the tower of light will be produced by 24 "light cannons," each of one billion candlepower, based in an 80-foot-high rainbow-colored building. The interior of the building will feature a moving ramp to convey visitors to the top floor from where they will begin a spiral walk downward past displays of various aspects of the electric power industry's operation.

These plans for the Power & Light Exhibit were announced at the 29th Annual Convention of the Edison Electric Institute by Ernest R. Acker, chairman of the EEI World's Fair Committee and president of the exhibit. The entire exhibit is being designed by V-E-K Associates, New York, N. Y., at an estimated cost of $6 to 7 million.

EEI Offers Employee Course in Electric Industry Fundamentals

A course in the fundamentals of the electric utility business has been developed by the Edison Electric Institute for employees of member companies. Part of a series of employee information programs being made available by EEI, the course is designed to be conducted over a six-month period in one-hour monthly sessions.

Subjects covered include the history and growth of the industry, its role in the American economy, basic industry terms, structure, future plans, aims of the sales program and rate-making. Course materials include colored filmstrips, demonstration materials, a booklet outlining the development and future plans of the industry and an instructor's manual offering guidance for conducting the course.

The first two phases of the program,

(Continued on page 19A)

INSTRUCTORS in the North Texas Section's lighting school in Wichita Falls were awarded small brass school bells as mementos of their teaching careers. Experienced teachers are, l. to r. (front row): James Knight, V. J. Graham, Paul A. Crick, Larry Cole, Robert Turpin, (back row) Robert Oetting, H. G. Jones, Ralph Heitzman, Bill Cook. Awards were presented at a joint meeting of the Section and the Dallas Residence Lighting Forum.

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Complete, Flexible, U/L Approved Lighting Control Systems Now Available!

Now, with the U/L Approved SCR Dimmer, Kliegl, the great name in lighting, makes available—*for the first time anywhere*—fully electronic, solid state, U/L Approved Lighting Control Systems.

Pioneered by the leader in the development of new lighting, dimming and control systems, Kliegl SCR Dimmers are available in 3, 6, 10 and 12 KW ratings.

Complete information on SCR Dimmers and Lighting Control Systems is available in a new catalog just published. Mail coupon today for your free copy or call us at COlumbus 5-0130 for full details.

lighting

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lighting fixtures molded of
LUSTREX® PERMA TONE

Gratelite Luminous Ceiling in Sayers Printing Company, St. Louis, Mo., manufactured by Edwin F. Guth Company, St. Louis; molded by Prolon Div., Prophylactic Brush Company, Florence, Mass.

Why is more Lustrex perma tone used for louvered ceilings than any other ultra-violet light-stabilized styrene? First, in clear white and a complete color range, perma tone exceeds IES-NEMA-SPI joint specifications for ultra-violet light-stabilized styrene. Second, you can illuminate large areas at low cost—with good diffusion, and uniform light distribution. Third, fixtures made of perma tone are light in weight, yet dimensionally stable.

There is also a new Impact Lustrex perma tone for extra toughness and flexibility for snap-fitting to metal parts, high resistance to abnormal abuse, lighter weight through thinner walls. For a comprehensive technical Report on both General Purpose and Impact Lustrex perma tone styrene—including accelerated aging test results and other valuable data on styrene in lighting—write to Monsanto Chemical Company, Plastics Division, Room 817, Springfield 2, Mass.

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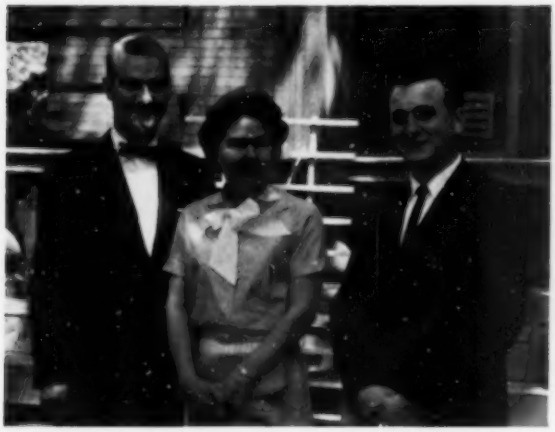


SPEAKERS at the Milwaukee Section's spring conference on recreational lighting included (left to right, photo above) Leonard Lessenich, Elsie Claiborne, Lowell Goone, (photo at right, back row), J. R. Chambers, IES President-Elect, Professor Paul J. Grogan, Charles Craig, (front row) Stacy Standley and J. H. Jensen. Speaker Richard Rayer and program moderator, I. L. Illing, are not shown. Seventy-five people attended the conference.

(*Continued from page* 16A)

"The American Economic System" and "American Freedom," have already been presented to approximately 60,000 electric company employees throughout the country.

North Texas Section Schedules Fourth Lighting Exposition

With three successful lighting expositions already to their credit, the North Texas Section of IES has announced plans for a fourth lighting show, to be held November 3, 1961, at the Will Rogers Memorial Buildings, Fort Worth, Texas. A symposium and demonstration is being planned in conjunction with the exposition.

Aim of the exposition is to acquaint electrical engineers, architects and others directly concerned with the specification of lighting equipment with the newest trends in illumination, and to promote the extensive use of better lighting. Only the latest developments in fixtures and allied accessories for commercial, industral and residential applications will be permitted in the show.

Further information on exhibit requirements and details of the show may be obtained from the exposition chairman, William F. Owens, Jr., 7160 Baker Blvd., Fort Worth 11, Texas.

Recreational Lighting Featured At Milwaukee Spring Conference

The 12th Annual Spring Lighting Conference sponsored by the Milwaukee Section of IES was devoted to the study of recreational lighting. Program featured discussion of the effective selection and use of fixtures, lighting for recreation rooms, living/family rooms, patios and gardens, home recreational games, playgrounds and parks and outdoor sports arenas. Speakers included James R. Chambers, incoming president of IES; Leonard Lessenich and Elsie Claiborne, Wisconsin Electric Power Co.; P. J. Grogan, University of Wisconsin; Lowell Goone, Halo Lighing Products; J. H. Jensen, General Electric Co., Nela Park; Richard Rayer, Steber Manufacturing Co., Charles Craig, Westinghouse Electric Corp., and Stacy Standley, Line Material Industries.

The seventy-five people registered for the conference, held June 2 at the Engineering Societies of Milwaukee Building, included representatives of electrical contractors, distributors and consultants, electric utilities, lighting manufacturers and city and county governments.

Phonon Maser Effect Demonstrated in Laboratory

Direct amplification of sound waves using microwave radio energy as a power source has recently been demonstrated by Dr. Edmund B. Tucker, General Electric Research Laboratory, Schenectady, N. Y. Amplification of the sound waves (called phonons) is accomplished by "stimulated emission" of energy by atoms as they change from a higher to lower energy level. This is the same mechanism which is used in the Maser (Microwave Amplification by Stimulated Emission of Radiation) to amplify electromagnetic radiation. Thus, the new phenomenon has been called the phonon Maser effect.

This is reported to be the first time that stimulated emission has been successfully used to amplify energy other than electromagnetic energy. Although no immediate commercial application of the phenomenon is predicted, it provides a significant extension of the principle of stimulated emission and represents an advance in the understanding of solid state physics. The technique may provide a valuable research tool in the experimental study of the role of phonons in many physical phenomena. For example, it may make possible an acoustic oscillator for generating sound waves of higher frequency than are presently attainable.

In both the Maser and phonon Maser effect, individual atoms are raised to a high energy state by irradiating or "pumping" them with high-frequency electromagnetic energy. Then, when signal energy of lower frequency is introduced, stimulated emission of the signal frequency occurs. Under proper conditions, the stimulated emission may be strong enough to produce amplification of the signal. In the Maser, pump, signal and output are all electromagnetic energy, whereas in the phonon Maser effect, only the pump is electromagnetic energy. The signal and output are both mechanical, or sound, energy.

The effect has been demonstrated with short pulses of very high frequency sound (9.3 kilomegacycle) in a ruby crystal. Ruby consists of alumina (Al_2O_3) with chromium ions as an impurity. When it is subjected to a magnetic field, the electrons on the chromium ions, acting as small magnets, tend to line up with the field. Each electron has four characteristic energy levels, corresponding to how closely it lines up with the applied field. Most of the electrons are in the lowest energy level, but can move to higher energy levels by absorbing energy at a certain resonant frequency, set by the magnetic field strength and characteristics of the electrons in the crystal. The

(*Continued on page* 22A)

Combining Lighting and Air Conditioning from One Efficient Unit...

Sylvania Sylva-Flo Troffers with Multi-Vent combine the functions of Air Conditioning and Lighting in the offices of Chicago and Northwestern Railway in Chicago's Riverside Plaza Building. All Sylva-Flo Troffers handle air—either supply or return—for peak performance.

DATA AND HIGHLIGHTS OF SYLVANIA SYLVA-FLO INSTALLATION

Name of Installation	Riverside Plaza Building, Chicago
Size of Installation	26 Floors (536,000 sq. ft.)
Number of Sylva-Flo units	Over 10,000
Function of Sylva-Flo Troffers	Lighting, Cooling, Temperate Heating
Ceiling Type	Metal Pan Acoustical
Ceiling Height	8′ 0″
Lamps per Troffer	Two 40-watt Rapid Start, Cool White
Shielding	Skytex Glass
Troffer Spacing	7′ 0″
Number of "Supply" Troffers / Number of "Return" Troffers	Ratio is approximately one "Supply" to one "Return."
Average Lighting Level (Measured)	70 Footcandles
Air handled by each unit	Interior units—72 CFM; Perimeter units—80 CFM
Architect-Engineer	Graham, Anderson, Probst & White, Chicago
Architect	William Heinkel
Mechanical Engineer	John Maras
Electrical Engineer	K. R. McGinnis
General Contractor	Sherman Olson Inc., Chicago
Electrical Contractor	Hyre Electric Co., Chicago
Mechanical Contractor	O. A. Wendt, Chicago

Sylvania's SYLVA-FLO Troffer with Multi-Vent to Provide All-Round Comfort for 25,000 Persons in Chicago's RIVERSIDE PLAZA OFFICE BUILDING

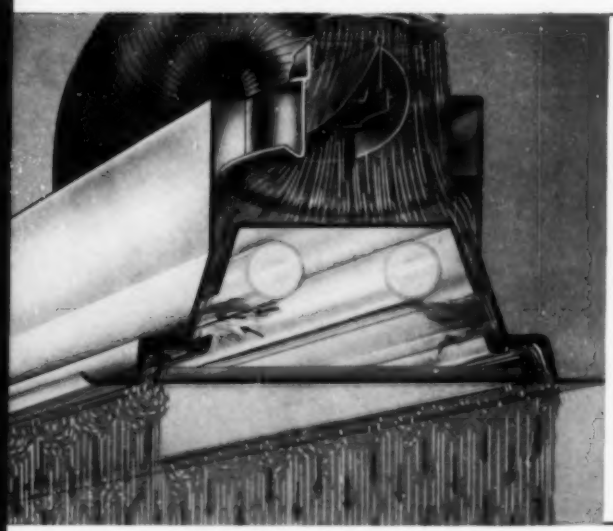
Occupants of Chicago's newly-remodeled Riverside Plaza will work in a quiet, well-lighted, comfortable atmosphere . . . thanks largely to Sylvania's Sylva-Flo Troffers with Multi-Vent. The 26 floors of this handsome office building will have lighting and air conditioning provided by Sylvania's efficient, attractive combination troffers.

All persons concerned with this installation have expressed satisfaction with the Sylva-Flo Troffers—the architect-engineer because of the appearance and effect in the completed offices; the contractors for the ease of installation and balancing air; and the building owner because of the economical cost and the all-round 'fresh air' comfort and balanced lighting.

Use this installation as a guide and check into the advantages of Sylvania's Sylva-Flo Troffers for your next new or remodeling project. Ask to see a sample unit. See for yourself the special features that make this fixture so advantageous from the standpoint of architect, engineer, contractor and user.

These features are completely discussed and illustrated in our new 20-page "Sylva-Flo" booklet. For your free copy, simply write to:

SYLVANIA LIGHTING PRODUCTS
A Division of SYLVANIA ELECTRIC PRODUCTS INC.
One 48th Street, Wheeling, West Virginia



SYLVANIA'S SYLVA-FLO TROFFER PROVIDES THESE ADVANTAGES IN ANY INSTALLATION

- The combination of quality lighting and air-handling.
- As much as 20% more light output.
- Superior air conditioning with the Multi-Vent System.
- Longer ballast life.
- Truer lamp color.
- Clean, uncluttered ceiling.
- Twin panels of soft light blend combination troffer with ceiling.
- Less maintenance.
- Quiet operation.
- Flexible, low-cost installation.
- Economical operation.
- Simple adjustment.
- Choice of shielding.
- Versatility of troffer widths and lengths.
- Selection of troffer housing to fit ceiling type.

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

PART of the student body at a session of the Southern California Section's advanced lighting seminar. The seminar was conducted in seven sessions and had an average attendance of 82. Registration was available for the entire course or for any number of individual lectures.

TWENTY-ONE of the 23 students enrolled in the Twin City Section's fundamentals of illumination course were awarded certificates of graduation by the Section. The ten-session course was under the direction of education committee chairman, O. C. Oberg.

(*Continued from page* 19A)

reverse transition from a high to low energy level can be made by emission of energy at the resonant frequency.

There is also interaction between the vibrations of the atoms in the crystal lattice and the energy states of the electrons, due to the electric fields of the atoms in the lattice. As the atoms vibrate, the electric fields, acting on the electrons, vary and this affects their energy levels. This interaction is what makes phonon Maser possible. Dr. Tucker's work enables it to be directly observed and accurately measured for the first time. His report on phonon amplification appears in the May 15 issue of *Physical Review Letters*.

Obituary

Leon T. Johnson (M), assistant to the manager of industrial and commercial sales, Public Service Electric & Gas Co., Newark, N. J., died suddenly on June 7 of a heart attack. He was 49.

Mr. Johnson had been with Public Service for 20 years, starting in 1941 as a sales representative, and serving progressively as design engineer, assistant supervisor of lighting sales, supervisor of lighting sales, and finally assistant to the sales manager. In 1956, he was honored with his company's McCarter Award, as the employee who made the greatest contribution to Public Service during the year.

Prior to joining Public Service, Mr. Johnson had been with the New Jersey Power and Light Co. and the Metropolitan Edison Co.

Mr. Johnson's IES membership dates from 1941 when he joined the Society as an Associate. He transferred to Member grade in 1945. He served IES as chairman of the New York Section and member of the committees on lighting and architecture, sign lighting, sustaining membership, data sheets and papers. In addition to his IES activities, Mr. Johnson was chairman of the commercial-industrial subcommittee and a member of the lighting information committee of the Better Light Better Sight Bureau. A graduate of Lafayette College in Easton, Pa., with a B.S. in electrical engineering, Mr. Johnson was a member of Phi Beta Kappa and Tau Beta Pi.

ABOUT PEOPLE

Parenthetical designations denote membership grade in the Society.

Clarence C. Keller (M) has been elected president of the Holophane Co., Inc., New York, N. Y., by action of the company's board of directors. Effective July 1, he succeeded **Charles Franck,** who will continue to serve as chief executive and chairman of the board. Mr. Keller is a former vice-president of IES.

The board of directors of the Consolidated Electric Lamp Co. (Champion Lamp), Lynn, Mass., has announced the election of **James A. Marsh** as president, **John P. Marsh** as vice-president and general manager, **David F. Erickson** as treasurer and controller and **Florence A. Hopkins** as assistant treasurer and clerk. James Marsh succeeds the recently deceased **Dwight H. Marsh.**

The election of **John G. Beam** as president of Thomas Industries Inc., Louisville, Ky., has been announced by the firm's board of directors. Mr. Beam succeeds **Lee B. Thomas,** who will continue as chairman of the board and chief executive officer.

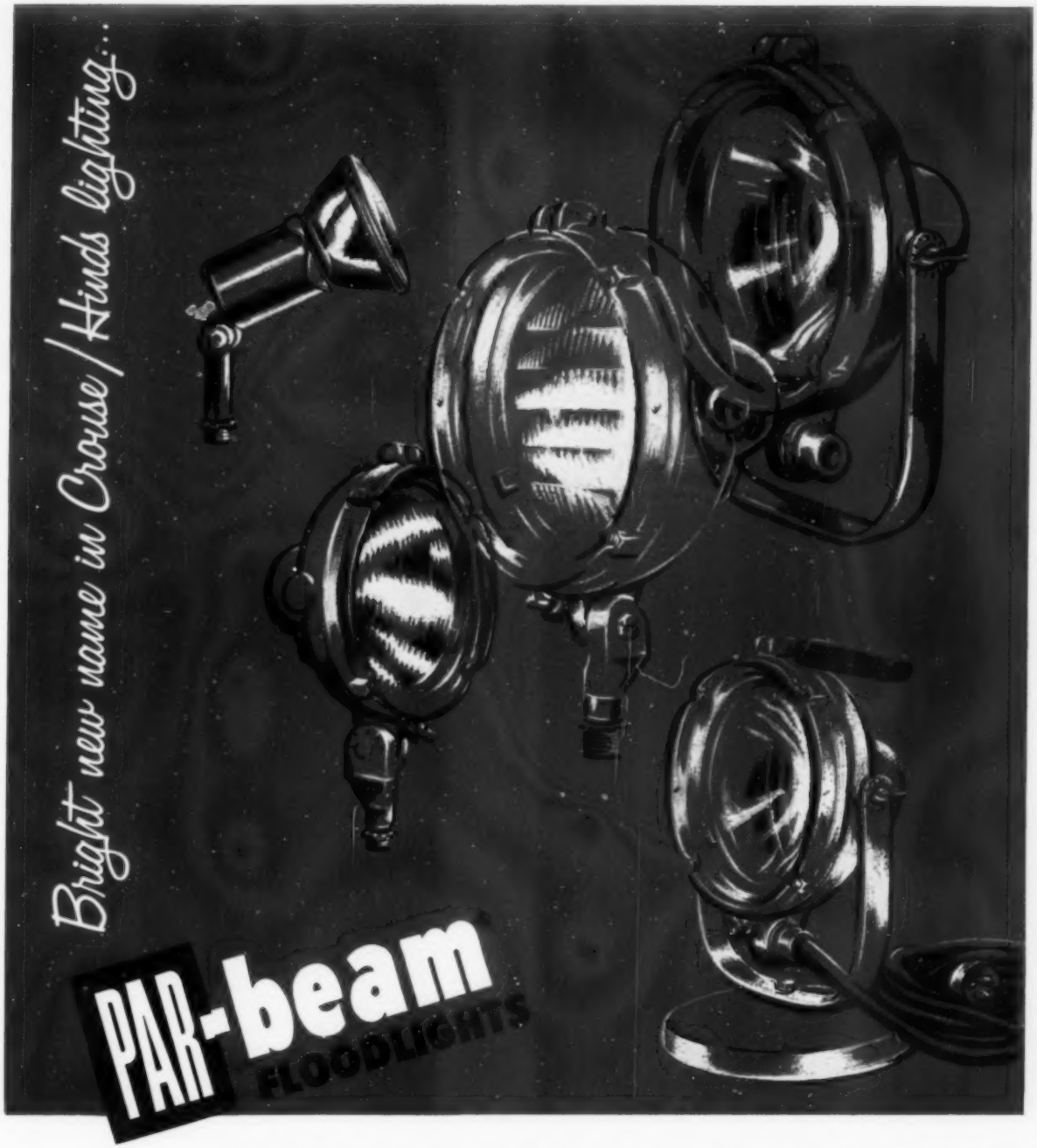
G. H. Meyner has been named president of The Frink Corp., Brooklyn, N. Y., and its subsidiary, Sterling Bronze Co. Prior to joining Frink, Mr. Meyner was associated with the Westinghouse Electric Corp. as director of consumer products manufacturing.

A. K. Morgan, J. S. Hamel (F) and **Donald Oenslager,** working in cooperation with the firms of **Clark and Rapuano** and **Hamel and Langer,** have been named as a consultant group on illumination for the 1964-1965 New York World's Fair. The group will be responsible for creating the nighttime atmosphere of public areas in addition to designing the many fountains which will be among the features of the Fair.

L. J. Segil, president of Luminous Ceilings Inc., Chicago, Ill, has announced the election of **Robert Jones** as president of Luminous Ceilings West Inc., a newly-created division. The new division will be concerned with marketing of the company's ceiling systems and lighting products for the 11 western states, including Hawaii and Alaska.

Henry L. Logan (F), vice-president in charge of research for the Holophane Co., Inc., New York, N. Y., was awarded an honorary Doctor of Laws degree by Iona College, New Rochelle, New York,

(*Continued on page* 24A)



Here's an all-new sealed beam floodlight series you'll want to know all about! Covering the entire range of applications, the new Crouse/Hinds PAR-beam Floodlights are available as follows: 150-300W for both medium and mogul screw base lamps. 300W and 500W, prong base, in portable, flat base or stem-mounting styles. Accessories include mounting plates, hoods, color screens.

Write for Bulletin 2727,
or see your Crouse/Hinds Distributor.

CROUSE HINDS
SYRACUSE NEW YORK

OFFICES: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tampa Tulsa Washington
RESIDENT REPRESENTATIVES: Albany, N.Y., Baltimore, Md., New Haven, Conn., Reading, Pa., Richmond, Va.
Crouse-Hinds of Canada, Ltd., Toronto, Ont. Crouse-Hinds-Domex, S.A. de C.V. Mexico City, D.F. Peterco, Sao Paulo, Brazil

(Continued from page 22A)

at commencement ceremonies on June 3. Mr. Logan was presented with the award in recognition of his pioneering contributions as inventor, author and lecturer, to the science of illumination and its application.

Phillips M. Darby has been named assistant vice-president — general sales manager for the Appleton Electric Co., Chicago, Ill. Mr. Darby has served the company for the past two years as general sales manager.

The Union Carbide Plastics Co., division of the Union Carbide Corp., New York, N. Y., has announced the appointment of Dr. **Gilbert I. Addis** as assistant director—vinyl planning for the Development Department. Dr. Addis will be located at the company's Bound Brook, N. J., plant.

The appointment of **Marvin R. Hoover** to the newly-created post of manager of marketing for the Lancaster Glass Corp., Lancaster, Ohio, has been announced by Dr. Robert K. Fox, president of the firm. Formerly, Mr. Hoover served as sales manager and supervised the company's advertising program.

John L. Kilpatrick (M) has been named sales manager of the Lamp and Process Coating Division of Silvray Lighting, Inc., New York, N. Y. Prior to joining Silvray, Mr. Kilpatrick was associated with the Litecraft Manufacturing Corp., Passaic, N. J.

G. E. Ormson has joined the Capacitor Department of the General Electric Co., Hudson Falls, N. Y. Formerly associated with the company's Cedar Rapids, Iowa, district office, Mr. Ormson in his new position will handle ballast capacitor sales. He succeeds **N. B. DeSilva,** who has been appointed as a sales engineer handling electric and electronic products in General Electric's Chicago district office.

The appointment of **Walter F. P. Werner** (M) as representative in the Cleveland territory has been announced by the Kirlin Co., Detroit, Mich.

Ray Green Associates, Cleveland, has been named northern Ohio representative for the Fostoria Corp., Fostoria, Ohio.

The Swivelier Co., Inc., New York, N. Y., has announced the appointments of two new representatives. **Finney-**

(Continued on page 27A)

It Seems to Me...

What Is Vertical Illumination?

More and more authors[1,2,3] are using the ambiguous term "vertical illumination" and its related terms "horizontal illumination," "vertical footcandles," etc. The clarity of lighting articles would be increased if such terms were avoided.

Where the words "vertical illumination" are used, it usually seems, from a study of the context, that the author meant "illumination on a vertical surface." However, this meaning for the words "vertical illumination" is so opposed to their normal meaning as to delay and temporarily confuse the reader.

Vertical illumination really means light flux traveling vertically onto a surface. Illumination is defined as the luminous flux per unit area on an intercepting surface. Hence, vertical illumination can only refer to vertical luminous flux, that is, the flow of light in a vertical direction. This meaning is in agreement with the paragraph on direction in the *IES Lighting Handbook,* Third Edition, page 219. As an example from another kind of motion, an elevator provides vertical transportation yet no one would think of calling it horizontal transportation because passengers disembark on a horizontal floor.

For effective transfer of information from author to reader, it is generally best to use the full wording for "illumination on a vertical surface" and similar terms. In some instances, the use of simpler terminology is sufficiently clear, such as the term "screen illumination" in motion picture usage.—P. D. CARMAN, Division of Applied Physics, National Research Council, Ottawa, Ont.

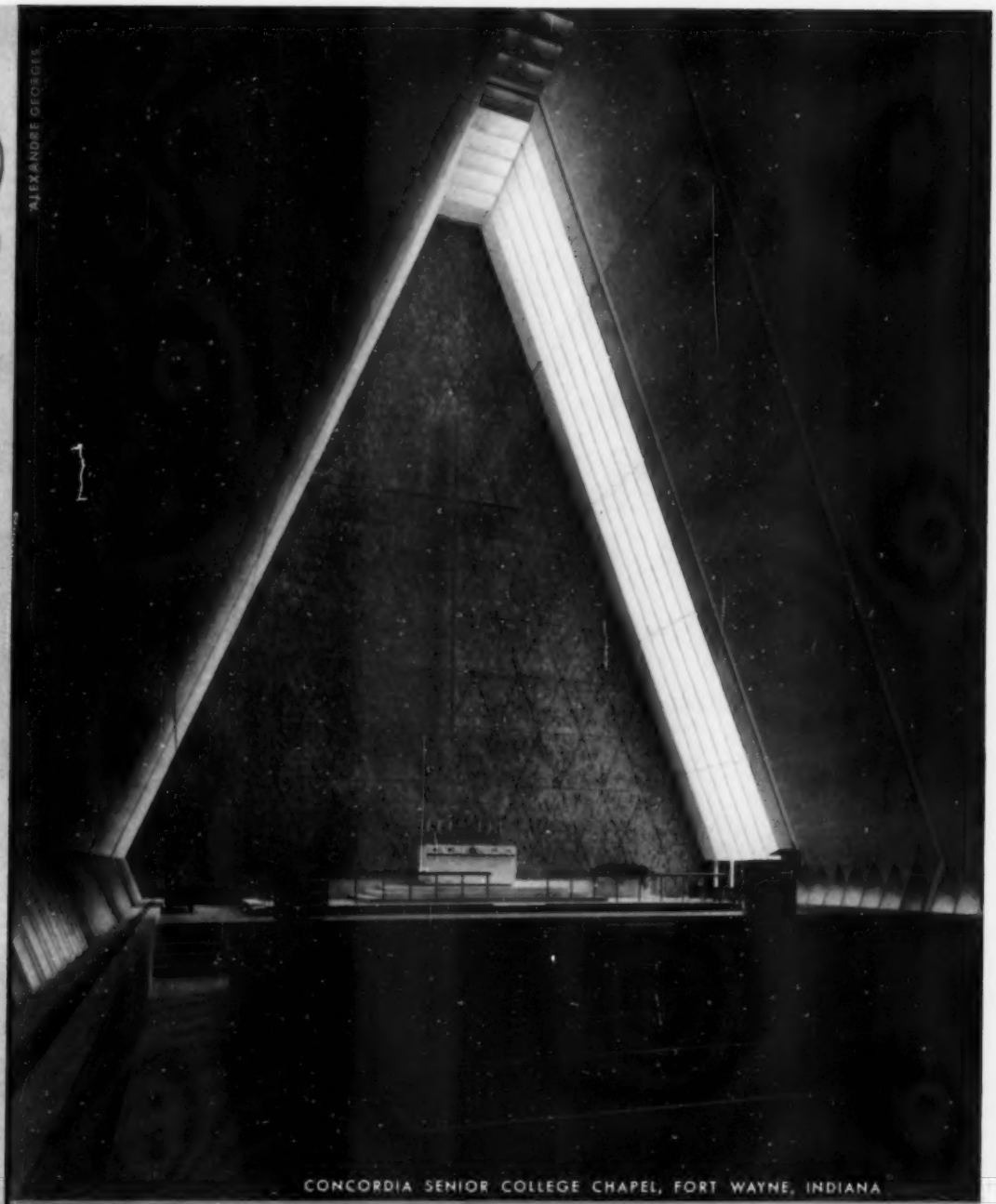
1. "Lighting Progress in 1959," ILLUMINATING ENGINEERING, Vol. LV, No. 3, p. 123, Fig. 36 (March 1960).
2. "Quartz Line Between the Goal Lines," *Light,* Vol. 30, No. 1, pp. 17-18.
3. "The Ubiquitous Ceiling," "Basic Plan for Golf Course Lighting," "Data Sheet 17-56, Lighting a Library," ILLUMINATING ENGINEERING, Vol. LVI, No. 3, Section I, pp. 118, 131, 147 (March 1961).

Clarity of Footcandle Recommendations

Lighting engineers are leaving themselves open to criticism in verbal presentations of the new IES footcandle levels. We have been saying such things as "you need 89.3 footcandles to see the green bug on the spinach," or "it took 3000 footcandles to see a stain on a piece of cloth." I agree that it would not be feasible or desirable to use a qualifying paragraph every time one gave a footcandle value, but I believe that some implied qualification is necessary. To give a complete presentation, one would have to say something like "according to the most reliable measurements thus far, an average observer would need 89 footcandles in order to detect five green bugs per second on the spinach with 99 per cent accuracy."

While we cannot and should not be this wordy every time we present a footcandle value, I do believe that it carries the wrong implications to give merely the bare number. I therefore suggest that we use the phrase "for quick and accurate seeing," in all such cases. Thus, one would say: "The reading of a poor copy from a spirit duplicator requires 100 footcandles for quick and accurate seeing."—WILLARD ALLPHIN, Sylvania Lighting Products, Salem, Mass.

RAMBUSCH LIGHTING



ALEXANDRE GEORGES

CONCORDIA SENIOR COLLEGE CHAPEL, FORT WAYNE, INDIANA

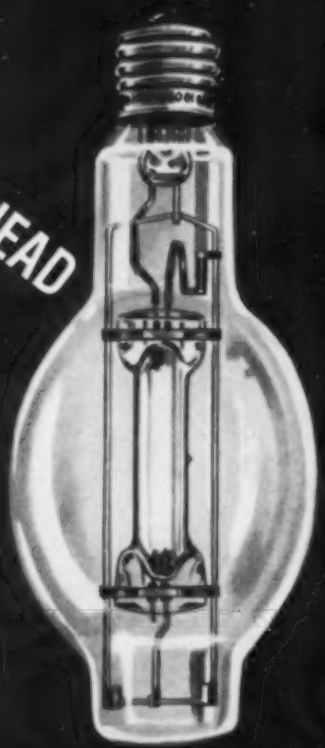
ARCHITECT: EERO SAARINEN & ASSOCIATES

RAMBUSCH DOWNLITE

For twenty years, the Rambusch Downlite has been used in lighting literally thousands of lofty interiors such as Banks and Churches. You benefit by this experience when you specify Rambusch. And you get a classic lighting device that is engineered as well as it is well made.

40 WEST 13th STREET, NEW YORK 11, NEW YORK

YOU'RE LIGHT YEARS AHEAD



WITH WESTINGHOUSE

WESTINGHOUSE "LIFEGUARD" MERCURY LAMPS DELIVER 25% MORE LIGHT...AT LOWEST PRICES EVER!

FOR INDUSTRIAL, STREET, PARKING LOT LIGHTING—Westinghouse "Lifeguard" Mercury Lamps give you up to 25% more light throughout their long life. Even after 12,000 hours or 3 years of service, you can expect almost the same light level as when the lamps were new! The reason . . . exclusive Westinghouse electrode design which virtually eliminates blackening light-robbing of the arc tube.

SAVE ON RELAMPING LABOR COST, TOO! "Lifeguard" lamps have the highest life rating of any lamps you can buy. In addition, they stand up in all kinds of unusually severe lighting conditions. Their special "Weather Duty" bulb construction is unaffected by rain, snow, corrosive gases or thermal shock! "Lifeguard" lamps are available in 100 to 1000 watt sizes, and are interchangeable with other types of the same wattage.

GET WESTINGHOUSE "LIFEGUARD" MERCURY LAMPS, NOW AT LOWEST PRICES EVER! And take advantage of the Westinghouse Lighting Cost Reduction Plan to cut costs by one or more of the following factors:

1. **Reduced cost of lamp purchases**
2. **Reduced lamp replacement labor costs**
3. **Increased lighting level at lowest prices ever**
4. **More efficient use of power**

For more information, contact your authorized Westinghouse Lamp agent or nearest Westinghouse sales office. *You can be sure . . . if it's Westinghouse.*

Westinghouse

Westinghouse Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey

(*Continued from page 24A*)

Irvin Associates will cover the Nashville area and **Thomas A. Marshall and Associates** will represent Swivelier in southern Florida.

Deaths

Edmond A. Burki, Milwaukee Section.
Harold Goodwin, Jr., Philadelphia Section.

IES Officers, 1961-1962

At the meeting of the IES Council on June 7, 1961, the Committee of Tellers presented their report on the results of the recent Society election. The following have been elected to the offices indicated, for the year beginning October 1, 1961.

NATIONAL OFFICERS

President—James B. Chambers, Appleton Electric Co., 1701-1759 Wellington Ave., Chicago, Ill.

Vice-President—J. Dixon Mitchell, Westinghouse Lamp Division, 5071 Peachtree Industrial Blvd., Chamblee, Ga.

General Secretary—Charles L. Amick, Day-Brite Lighting Inc., P.O. Box 141, St. Louis, Mo.

Treasurer—A. C. Barr, General Electric Co., Nela Park, Cleveland, Ohio.

Directors (Until 1964)—John M. Chorlton, Toronto Board of Education, 155 College St., Toronto, Ont.; W. P. Lowell, Jr., Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

Regional Vice-Presidents—Canadian Region—Jean Paul Cristel, The Shawinigan Water & Power Co., 600 Dorchester St., W., Montreal, Que.; *East Central Region*—Shelton Ragland, Virginia Electric & Power Co., P. O. Box 1194, Richmond, Va.; *Inter-Mountain Region*—Robert Godemann, Arizona Public Service Co., P.O. Box 2591, Phoenix, Ariz.; *Southeastern Region*—T. Llew Cordle, J. N. Pease & Co., P.O. Box 10336, Charlotte, N. C.; *Southwestern Region*—R. G. Turpin, Sylvania Electric Products Inc., 100 Fordyce St., Dallas, Texas.

ALABAMA SECTION

Chairman—R. D. Steele, Alabama Power Co., 2100 1st Ave., N., Birmingham, Ala.

Vice-Chairman—P. Krahenbuhl, Canterbury Electric Co., 1013 7th Ave. S., Birmingham, Ala.

Secretary—G. McLeod, 1906 Ninth Ave. S., Birmingham, Ala.

Board of Managers — R. Fulmer, E. B. Richey, M. A. Perreault, W. D. Parker.

ALAMO SECTION

Chairman—T. A. Milam, 138 Marcia Pl., San Antonio, Texas.

Vice-Chairman—W. S. Smith, Square D Co., 519 Travis Bldg., San Antonio, Texas.

Secretary—G. L. Kocian, Jr., Graybar Electric Co., Inc., 1223 N. Hackberry St., San Antonio, Texas.

Board of Managers—F. A. Covington, Sr., G. B. Davis, M. E. Staley, K. L. Cotton

ARIZONA SECTION

Chairman—William Benndorf, 221 E. Camelback Rd., Phoenix, Ariz.

Vice-Chairman—D. L. Ruff, Arizona Public Service Co., P.O. Box 2591, Phoenix, Ariz.

Secretary—W. B. Keller, 5301 North 23rd St., Phoenix, Ariz.

Board of Managers—G. A. Baker, R. L. Heubeck, S. S. Lambe, H. Stead.

ARKANSAS CHAPTER

Chairman—George E. Ellefson, Jr., Leo L. Landauer & Associates, 1800 E. 26th, Little Rock, Ark.

Vice-Chairman — L. C. Keathley, Arkansas Electric Co., Markham & Scott Sts., Little Rock, Ark.

Secretary—J. E. Greene, 7424 Illinois St., Little Rock, Ark.

ARK-LA-TEX CHAPTER

Chairman—Paul Osteen, Interstate Electric Co., 1414 Culpeeper, P. O. Box 1094, Shreveport, La.

Vice-Chairman—R. C. Jackson, Cahn Electric Co., Inc., 708 Milam St., Shreveport, La.

Secretary — D. R. Williams, Southwestern Electric Power Co., 428 Travis St., Shreveport, La.

ARROWHEAD CHAPTER

Chairman—James R. Goddard, 807 N. Vista, Rialto, Calif.

Vice-Chairman—James Cox, California Electric Power Co., P. O. Box 176, Corona, Calif.

Secretary—Jim Hicks, Southern California Edison, 577 "D" St., San Bernardino, Calif.

BLUENOSE CHAPTER

Chairman—F. C. O'Neill, F. C. O'Neill & Associates, 54 Grafton St., Halifax, N. S.

Vice-Chairman—J. G. Ferraris, J. A. Wilson Lighting & Display, Ltd., P. O. Box 102, Armdale P. O., Halifax, N. S.

Secretary—Don Matheson, Bryant Electric Co., Ltd., 129 Hollis St., Halifax, N. S.

BRITISH COLUMBIA SECTION

Chairman—D. E. Holland, 1029 W. 23 St., N. Vancouver, B. C.

Vice-Chairman—Miss D. McGregor, British Columbia Electric Co., Ltd., 970 Burrard St., Vancouver, B. C.

Secretary—J. A. Eadie, Brettell Electric Ltd., 541 Howe St., Vancouver, B. C.

Board of Managers—E. A. Adams, A. M. Anderson, H. Lindgaard, J. C. Spencer.

CAPITAL SECTION

Chairman—C. E. O'Daniel, Potomac Electric Power Co., 929 "E" Street N.W., Washington, D. C.

Vice-Chairman—N. H. Boehm, General Electric Co., 777 14th St., N.W., Washington, D. C.

Secretary—T. T. Thurston, Westinghouse Electric Corp., 1625 "K" St., N.W., Washington, D. C.

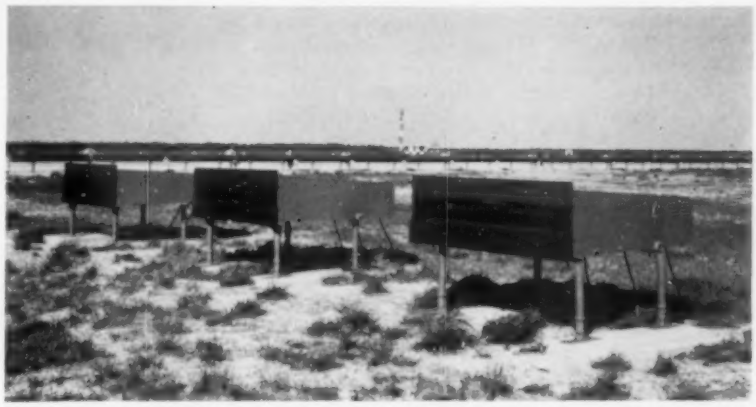
Board of Managers—K. W. Cobb, M. H. Dixon, Jr., B. Goodman, P. Norris .

CENTRAL FLORIDA CHAPTER

Chairman—John T. Joiner, 2221 Stanley Ave., Orlando, Fla.

(*Continued on page 28A*)

Installations in the News...



Visual Glide Slope Indicator Guides Airplane Descents

Visual Glide Slope Indicator, which guides pilots to the theoretical glide slope of a runway, is a recent aviation lighting development which provides an accurately illuminated corridor visible upwards to 15 miles at night and 5 miles during the day. Attitude, position and course can be continuously checked during final stages of approach, down to the point of flareout.

The system, originally developed in England by the Royal Aircraft Establishment, uses two parallel, transverse, winged-out light bars, one located 500 feet and one 1000 feet or more from the runway threshold, depending upon glide slope angle. Each light bar is designed to project a low beam sector of red, a high beam sector of white, and a transitional sector of pink. Accurate placement and vertical adjustment of each complete transverse bar develops two dual-color light beams, so related as to produce a corridor of light in which the near bar appears white and the far bar red, indicating conformity with the glide path. If the plane deviates from the glide path, different color patterns are visible.

Each bar of light consists of three boxes each containing three PAR64 200-watt sealed beam lamps with red filters over two-thirds of their surfaces. Beams pass through horizontal slits at the front of the cases for proper beam distribution and color cutoff. Photo and data are courtesy of Sylvania Lighting Products, Ipswich, Mass.

Contributing to UEC Building Fund

Leading all Sections and Chapters in contributions to the IES quota for the United Engineering Center Building Fund is the Chicago Section whose "king-sized" check for almost $1600 was presented to 1960-1961 president, R. G. Slauer (left in photo at right), and 1961-1962 president, J. R. Chambers (right), by North Central RVP, Richard Smart. In photo at left below, Norman Harrington (left), Western New York Section UEC solicitation chairman, presents his Section's contribution to IES Technical Director, C. L. Crouch. In photo at right below, Stacy Standley (left), Milwaukee UEC chairman, presents contribution to Milwaukee Section chairman, Ed Schnoll. New IES Headquarters offices will be located on the ninth floor of the United Engineering Center building, scheduled for completion during August.

(*Continued from page* 27A)

Vice-Chairman—G. W. Connelly, Florida Power & Light Co., P. O. Box 1071, Daytona Beach, Fla.
Secretary—Robert W. Peacock, 730 Nottingham, Orlando, Fla.

Central New York Section

Chairman—D. R. Brown, Crouse-Hinds Co., Wolf & 7th North St., Syracuse, N. Y.
Secretary—V. J. Moore, Niagara Mohawk Power Corp., 300 Erie Blvd., W., Syracuse, N. Y.
Board of Managers—R. C. Swanson, R. O. Clark, O. C. Nord, E. R. Hunt.

Chicago Section

Chairman—E. W. Witte, Benjamin Division, Thomas Industries, Inc., Des Plaines, Ill.
Vice-Chairman — A. J. Morelli, Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill.
Secretary—V. T. Kempf, 194 Edgemond Lane, Barrington, Ill.
Board of Managers—E. H. Gallet, H. E. Sereika, M. Cohen, J. E. Pallagi.

Chinook Chapter

Chairman — Niels Johansen, Ariel Davis Manufacturing Co., Ltd., 3648 Manchester Rd., Calgary, Alta.
Vice-Chairman—G. W. McKenzie, Calgary Power Ltd., Box 190, Calgary, Alta.
Secretary—Jacob Hovdebo, Canadian General Electric Co., Ltd., 3603 8th St., S. E., Calgary, Alta.

Cleveland Section

Chairman—C. J. Allen, General Electric Co., Nela Park, Cleveland, Ohio.
Secretary—J. Needham, 9310 Berkshire Rd., Cleveland, Ohio.
Board of Managers—J. Bale, L. Sternberg, J. Jensen, E. Creed, T. Norton.

Coastal Bend Chapter

Chairman—C. D. Myers, Central Power & Light Co., Box 1369, Alice, Texas.
Secretary—Gary Klingaman, Westinghouse Electric Corp., 206 Kaffie Bldg., Corpus Christi, Texas.

Coastal Empire Chapter

Chairman—Waring B. Steiner, Fluorescent Maintenance Service, 1226 E. Anderson St., Savannah, Ga.
Vice-Chairman—H. F. Turner, Turner & Co., 1021 E. Anderson St., Savannah, Ga.
Secretary—Ronald W. Edwards, Rabey Electric Co., Box 3556, Station B, Savannah, Ga.

Connecticut Section

Chairman—R. H. Chase, Hartford Electric Light Co., 266 Pearl St., Hartford, Conn.
Vice-Chairman—A. B. Smith, Connecticut Light & Power Co., 66 Curtis St., New Britain, Conn.
Secretary—T. Ake, The Miller Co., 99 Center St., Meriden, Conn.
Board of Managers—J. J. Neidhart, R. Donnelly, F. Brown, J. McInnis.

Cornhusker Section

Chairman—E. C. Knudson, Leo A. Daly Co., 8600 Indian Hills Dr., Omaha, Nebr.
Vice-Chairman—M. Burris, Jr., Iowa Power Service Co., Orpheum E. Bldg., 6th & Pierce Sts., Sioux City, Ia.
Secretary—C. I. Wallin, 5335 N. 28th Ave., Omaha, Nebr.
Board of Managers—J. H. Smith, J. H. Riisness, R. E. Price, R. W. Brewer.

Diablo Section

Chairman—F. Bertolone, 19367 Waverly Ave., Hayward, Calif.
Vice-Chairman—H. Lauer, Pacific Gas & Electric Co., 625 Clay St., Oakland, Calif.
Secretary—J. Schreiber, General Electric Co., 999 98th St., Oakland, Calif.
Board of Managers—L. Komor, G. Radford, A. B. Emmes, J. McAdoo.

Eastern New York Section

Chairman—R. H. Rice, Westinghouse Electric Corp., 17 Warehouse Row, Albany, N. Y.
Vice-Chairman — C. E. Waldron, Niagara Mohawk Power Corp., 126 State St., Albany, N. Y.
Secretary—A. Rosen, 1053 Garner Ave., Schenectady, N. Y.
Board of Managers—R. L. Cooper, R. F. Hussey, L. Lamboy, J. Larabee.

Eastern Pennsylvania Section

Chairman—J. H. Bicher, General Electric Supply Corp., 1041 Rockland St., Reading, Pa.
Vice-Chairman—R. J. Mott, Electro-Silv-A-

(*Continued on page* 30A)

NOW...
Single Lamp Visionaires® Join the STARAMA Series

This new, plastic enclosed, single-lamp Visionaire® forms a matching complement to the 2 and 4-lamp #7400 **STARAMA** series. Now architects, engineers and building owners can plan a unified lighting system from narrow corridors to large spaces with fixtures of the same style and lighting characteristics.

The single-lamp **STARAMA** is also available with clear SUNLUX® lens and translucent OPALUX diffusing panels. These are of polystyrene, formulated for longer-lasting resistance to discoloration. Translucent plastic sides are interlocked with the bottom panels forming a light-weight enclosure. Sturdily framed in metal, the diffusers open from either side. The advantages of easy installation add to the **STARAMA** flexibility . . . now with 1, 2 or 4 lamps.

Write for bulletin A84-11

SUNBEAM LIGHTING COMPANY, LOS ANGELES, CALIFORNIA | GARY, INDIANA

1960-1961 IES Council members enjoy a relaxed moment during their last meeting of the fiscal year. At head of table, l. to r.: J. D. Mitchell, general secretary; R. G. Slauer, president; J. R. Chambers, first vice-president. Meeting was held June 6-7 in New York City.

(*Continued from page* 28A)

King Corp., Spruce & Water Sts., Reading, Pa.
Secretary—N. C. Trullson, 3015 Hillcrest Ave., Oxford Park, Allentown, Pa.
Board of Managers — F. J. Hartwigsen, J. P. Rehman, P. H. Stanley, C. H. Steigerwalt, Jr.

EDMONTON SECTION

Chairman—W. R. Vernon, Eric Ackland & Associates Ltd., 621 Northern Hardware Bldg., Edmonton, Alta.
Vice-Chairman—E. B. Allsopp, Allsopp & Simpson Ltd., 10562 — 109 St., Edmonton, Alta.
Secretary—R. Young, 14515 97 Ave., Edmonton, Alta.
Board of Managers—J. Bradshaw, A. Robertson, G. Hammond, F. Wilson.

FLORIDA SECTION

Chairman—R. R. Minton, Bishop & Johnson, Inc., 442 W. Lafayette, Tampa, Fla.
Vice-Chairman—H. G. Hayes, Florida Power & Light Co., 1549 State St., Sarasota, Fla.
Secretary — Elizabeth S. Byrnes, Tampa Electric Co., P.O. Box 111, Tampa, Fla.
Board of Managers—S. Carastro, R. Y. Fernandez, R. W. Kerlikoske, J. A. Pettus.

FOREST CITY (LONDON) CHAPTER

Chairman — O. Dunsmore, 74 James St., Lambeth, Ont.
Secretary — J. Vanderheiden, 7 Lockyer Place, London, Ont.

GEORGIA SECTION

Chairman—L. R. Bush, 26 Peachtree Place, N.W., Atlanta, Ga.
Vice-Chairman—A. H. Lundstrom, Whitehead Electric Co., 210 14th St., N.W., Atlanta, Ga.
Secretary—W. H. Newman, Box 524, Decatur, Ga.
Board of Managers—J. J. Burns, W. T. Cantrell, C. R. Minors, W. L. Hibble.

GOLDEN GATE SECTION

Chairman—A. S. Taylor, 1037 Cortez Ave., Burlingame, Calif.
Vice-Chairman—R. L. Sawyier, Pacific Gas & Electric Co., 17th & Clay Sts., Oakland, Calif.
Secretary—G. W. Smith, Smith & Garthorne, 1122 Market St., San Francisco, Calif.
Board of Managers—F. H. Buhme, W. G. Bayha, J. C. Epperson, B. B. Howard.

GOLDEN WEST CHAPTER

Chairman—R. Champagne, Electrolier Mfg. Co. Ltd., 202-A Brent Bldg., Regina, Sask.
Vice-Chairman — T. McGorrian, Northern Electric Co. Ltd., 2300 Dewdney Ave., Regina, Sask.
Secretary — E. Bolton, Electric Service League, 403 Kerr Bldg., Regina, Sask.

GULF COAST CHAPTER

Chairman—J. E. Springer, P. O. Box 1349, Mobile, Ala.
Vice-Chairman—R. Potter, P. O. Box 1511 Pensacola, Fla.
Secretary—Sidney W. Snyder, P. O. Box 1349, Mobile, Ala.

HAMILTON, ONTARIO CHAPTER

Chairman—J. E. Quist, Prack & Prack, Architects, 310 Main St., E., Hamilton, Ont.
Secretary—L. Gasseon, L. H. Schwindt Co., Ltd., P. O. Box 516, Burlington, Ont.

HEART OF AMERICA SECTION

Chairman—G. V. Dawson, H. E. Williams Co., 4838 N. Gladstone St., Kansas City, Mo.
Vice-Chairman—J. R. Custead, Kansas City Power & Light Co., 1330 Baltimore, Kansas City, Mo.
Secretary—D. J. Stewart, Evans Electrical Construction Co., 734 Armstrong, Kansas City, Kans.
Board of Managers — R. W. Wilson, N. Thompson, A. E. Bodner, C. J. Purcell.

HOUSATONIC CHAPTER

Chairman—Russell W. Benjamin, Jr., 1115 Broad St., Bridgeport, Conn.
Vice-Chairman—Daniel Gaidosz, 222 Washington Ave., West Haven, Conn.
Secretary—John C. Gage, Jr., P. O. Box 700, Norwalk, Conn.

INDIANA SECTION

Chairman — N. Schnitker, Indianapolis Power & Light Co., 25 Monument Circle, Indianapolis, Ind.
Vice-Chairman—W. Smith, Electrical Equipment Co., 26 S. Senate Ave., Indianapolis, Ind.
Secretary—B. R. Boylan, General Electric Co., 3333 N. Meridian St., Indianapolis, Ind.
Board of Managers—G. Ramsford, M. B. Wolfe, A. Wiese, H. W. Claffey, Jr.

INLAND EMPIRE CHAPTER

Chairman — Ray D. Rookey, Washington Power Co., W. 825 Trent, Spokane, Wash.
Vice-Chairman — John Wessells, Columbia Electric, P.O. Box 743, Pasco, Wash.
Secretary—Robert L. Patrick, Thomas Industries, Inc., 4027 N. Elgin, Spokane, Wash.

IOWA SECTION

Chairman—A. Oja, George C. Mittauer & Associates, 1407 Memorial Drive, Cedar Rapids, Ia.
Vice-Chairman—H. Taylor, 550-31st St., Des Moines, Ia.
Secretary — E. H. Ford, Iowa Electric Light & Power Co., Box 351, Cedar Rapids, Ia.
Board of Managers—Mary Stafford, L. Kingsley, D. Owens, L. DeHoet.

MARITIME CHAPTER

Chairman — T. E. Wallace, N.B.E.P.C., 527 King St., Fredericton, N. B.
Vice-Chairman—H. H. Cromwell, 153 King St. E., St. John, N. B.
Secretary — Hayward Grant, N.B.E.P.C., 527 King St., Fredericton, N. B.

MARYLAND SECTION

Chairman—J. C. Burdette, Egli & Gompf, Inc., 1003 N. Calvert St., Baltimore, Md.
Secretary—C. L. Bureau, Douty & Downie, 2323 Maryland Ave., Baltimore, Md.
Board of Managers—P. K. Allen, R. Dunlop, L. W. Morgan, G. W. Younglove, N. S. Weiss.

MIAMI VALLEY SECTION

Chairman—S. L. Burnham, General Electric Co., 225 N. Wilkinson St., Dayton, Ohio.
Vice-Chairman—H. S. Metcalf, Martin Electric Co., 310 E. Second St., Dayton, Ohio.
Secretary—A. M. Lafferty, Jr., Stein Electric Co., 1219 E. Third St., Dayton, Ohio.
Board of Managers—H. C. Burrall, R. E. Corwin, G. A. Grier, L. R. McKusick.

MICHIGAN SECTION

Chairman — W. A. Hedrich, University of Michigan, Ann Arbor, Mich.
Secretary—G. Thornton, S. P. Ecclestone & Sons, Inc., 18989 James Couzens Highway, Detroit, Mich.
Board of Managers—D. Brown, J. Fenn, V. L. Kochajda, A. Migdal, S. S. Squillace.

MID-SOUTH CHAPTER

Chairman — Charles D. Hooper, Memphis Light, Gas & Water Division, P.O. Box 388, Memphis, Tenn.
Vice-Chairman—Charles Dennis, Jr., Byrd Electric Co., 210 N. Evergreen, Memphis, Tenn.
Secretary—Robert J. Merritt, 130 N. Greer, Memphis, Tenn.

MILWAUKEE SECTION

Chairman—C. Knoerr, Knoerr & Fischer, Inc., 1015 N. Milwaukee St., Milwaukee, Wis.
Vice-Chairman—K. Hartwig, Graybar Electric Co., 180 N. Jefferson St., Milwaukee, Wis.
Secretary—W. Schumaker, Northern Light Co., 1661 N. Water St., Milwaukee, Wis.
Board of Managers—G. Dolan, R. Garber, L. Odry, E. Schnoll.

MISSISSIPPI CHAPTER

Chairman—Stephen H. Turner, Mississippi Power & Light Co., 144 S. Congress, Jackson, Miss.
Vice-Chairman — James F. Branson, Jr., P. O. Box 1642, Jackson, Miss.
Secretary—John A. Clark, Stuart C. Irby Co., 815 S. State St., Jackson, Miss.

MONTREAL SECTION

Chairman—W. G. Moore, Electrolier Mfg. Co. Ltd., 5849 Boyer St., Montreal, Que.
Secretary—W. J. McCormick, Sylvania Electric (Canada) Ltd., 6233 Cote de Lieme Rd., Montreal, Que.
Board of Managers—P. Aerts, J. H. Beaudet, A. Dandenault, H. Z. Goldstein, G. E. Mean.

MOTHER LODE SECTION

Chairman—L. Van Nostrand, 1400 N. St., Sacramento, Calif.
Vice-Chairman—D. Goodman, Pacific Gas & Electric Co., 345 Channel St., Stockton, Calif.
Secretary—G. W. Burke, Jr., 1651 Parkmead Way, Sacramento, Calif.
Board of Managers—C. Baker, Jr., G. Cleland, E. Harris, W. Koblik.

NEW ENGLAND SECTION

Chairman—J. E. Carr, General Electric Co., 140 Federal St., Boston, Mass.
Vice-Chairman — J. A. MacCracken, New England Power Service Co., 441 Stuart St., Boston, Mass.

(*Continued on page* 32A)

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(Continued from page 30A)

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Board of Managers—P. M. Crosby, P. J. Lepore, W. M. Reeves, R. R. Wylie.

New Jersey Section

Chairman—M. H. Silverman, Fluores-O-Lite Co., Evans Terminal, Hillside, N. J.
Vice-Chairman—J. I. Hargis, Day-Brite Lighting, Inc., P. O. Box 349, Bloomfield, N. J.
Secretary—R. B. Cole, Jr., Jersey Central Power & Light Co., Madison Ave. at Punch Bowl Road, Morristown, N. J.
Board of Managers—E. C. Bataille, F. C. Infanger, H. O. Spliethoff, H. W. Wenson.

New Orleans Section

Chairman—J. A. Stelly, Gulf States Utilities Co., 446 North Blvd., Baton Rouge, La.
Vice-Chairman—T. L. Hall, Halleo Lighting Manufacturing Co., 517 S. Carrollton Ave., New Orleans, La.
Secretary—V. L. Goodman, L. N. Goodman & Associates, 405 Audubon Bldg., New Orleans, La.
Board of Managers—O. E. Barron, Jr., C. S. Goodgame, E. J. Hagan, J. A. Keller, Jr.

New York Section

Chairman—R. G. Williams, 71 Birch Lane, Bar Harbour, Massapequa, N. Y.
Vice-Chairman—H. L. Wald, Wald & Zigas, 10 E. 39th St., Suite 1005, New York, N. Y.
Secretary—E. O. Kassman, Westinghouse Electric Corp., 40 Wall St., New York, N. Y.
Board of Managers—C. S. Bramley, J. F. Dickerhoff, D. O'Brien, I. Fishman.

North Texas Section

Chairman—H. G. Jones, Texas Electric Service Co., P. O. Box 970, Ft. Worth, Texas.
Vice-Chairman—H. D. Samuels, Texas Power & Light Co., P. O. Box 6331, Dallas, Texas.
Secretary—W. T. Kimery, Dallas Power & Light Co., 1506 Commerce, Dallas, Texas.
Board of Managers—D. L. Cook, C. M. Cockrell, T. J. Ewbank, G. H. Thaxton.

Northumberland Chapter

Chairman—Lloyd W. Vincent, HiLite Electric Ltd., 347 St. George St., Moncton, N. B.
Secretary—C. Owen Lockhart, 31 Portledge Ave., Moncton, N. B.

Northwestern Ohio Section

Chairman—T. Wagner, Westinghouse Electric Supply Co., 1225 Indiana Ave., Toledo, Ohio.
Vice-Chairman—C. Crookes, Toledo Edison Co., Edison Bldg., Toledo, Ohio.
Secretary—Mrs. A. Wegener, 4414 Woodmont, Toledo, Ohio.
Board of Managers—H. E. Carney, H. Daykin, O. Levi, R. Rogers.

Ohio Valley Section

Chairman—H. J. Gruber, Cincinnati Gas & Electric Co., 4th & Main Sts., Cincinnati, Ohio.
Vice-Chairman—J. B. Murnane, General Electric Co., 990 Nassau St., Cincinnati, Ohio.
Secretary—E. J. McGinnis, Cincinnati Electrical Association, 920 Federal Reserve Bldg., Cincinnati, Ohio.
Board of Managers—R. L. Campbell, J. B. O'Donnell, F. B. MacRae, R. C. Smith.

Oil Capital Section

Chairman—J. C. Penafeather, 723 S. 90th East Ave., Tulsa, Okla.
Vice-Chairman—R. G. Smith, General Electric Co., 1101 S. Main St., Tulsa, Okla.
Secretary—A. N. De'Espenza, Tri State Sales Co., 2415 S. Norwood Ave., Tulsa, Okla.
Board of Managers—R. Almond, J. C. Netherton, Jr., J. R. Seay, W. T. Walters.

Oregon Section

Chairman—A. Natalie, Pacific Power & Light Co., 920 S.W. 6th, Portland, Ore.
Vice-Chairman—R. S. Wickham, Portland General Electric Co., 621 S.W. Alder St., Portland, Ore.
Secretary—J. E. Beck, Pacific Power & Light Co., Public Service Bldg., Portland, Ore.
Board of Managers—H. Hagen, Jr., L. R. Koroch, R. Smith, J. Yoneyama.

Ottawa Section

Chairman—A. F. Cross, P. O. Box 735, R. R. 5, Honey Gables, Ottawa, Ont.
Secretary—W. E. Emon, Canadian Westinghouse Co. Ltd., 1800 Bank St., Ottawa, Ont.
Board of Managers—H. Callan, A. D. Hazelgrove, W. F. McGarry, H. A. Park, D. E. Wilson.

Palmetto Section

Chairman—Mireille Thompson, Laurel Hill Rt. 4, Brevard Road, Box 66, Hendersonville, N. C.
Vice-Chairman—E. Williams, Cashion Electricians Inc., 3415 Main, Columbia, S. C.
Secretary—B. Watson, Duke Power Co., W. Main St., Spartanburg, S. C.
Board of Managers—H. H. Buchanan, M. Efron, M. Horner, J. Smyre.

Panhandle Chapter

Chairman—Leroy Gross, Nunn Electric Supply Corp., 105 Polk St., Amarillo, Texas.
Vice-Chairman—Dwain Garrett, General Electric Supply Co., 701 E. Fifth St., Amarillo, Texas.
Secretary—Ray H. Rampey, Westinghouse Lamp Division, 1903 Lawndale Dr., Amarillo, Texas.

Philadelphia Section

Chairman—R. P. Shelly, Westinghouse Electric Corp., 1300 Belmont Ave., Philadelphia, Pa.
Vice-Chairman—W. V. Wivel, General Electric Co., Route 202 & Expressway, P. O. Box 525, King of Prussia, Pa.
Secretary—G. C. Rees, Westinghouse Electric Corp., 1300 Belmont Ave., Philadelphia, Pa.
Board of Managers—F. J. Roche, W. G. Speed, P. R. Steele, E. W. Zimmers.

Pittsburgh Section

Chairman—H. J. Mazur, Westinghouse Electric Corp., 306 4th Ave., Pittsburgh, Pa.
Vice-Chairman—L. W. Hornfeck, 711 Pennsylvania Ave. E., Pittsburgh, Pa.
Secretary—J. Pernicano, General Electric Co., 2100 Oliver Bldg., Mellon Square, Pittsburgh, Pa.
Board of Managers—D. V. Hendrickson, D. Loucks, J. B. McNall, D. C. Thomas.

Puget Sound Section

Chairman—D. A. Olson, D. A. Olson Co., 420 E. 45th St., Seattle, Wash.
Vice-Chairman—G. F. Fitzmaurice, Beverly A. Travis & Associates, 1117 2nd Ave. Bldg., Room 407, Seattle, Wash.
Secretary—E. A. Matlock, Puget Sound Power & Light Co., 286 4th St., Bremerton, Wash.
Board of Managers—D. G. Cline, T. J. Cross, R. Weston, G. D. Wirt.

Rochester Section

Chairman—D. H. Vincent, General Electric Co., 35 Chestnut St., Room 605, Rochester, N. Y.
Secretary—D. Carroll, 42 Woodline Drive, Penfield, N. Y.
Board of Managers—R. E. Cherne, R. A. Fraim, Jr., H. S. Glick, C. Pollack, R. C. Simmons.

Rocky Mountain Section

Chairman—F. H. Rosenquist, Public Service Co. of Colorado, 900 15th St., Room 211, Denver, Colo.
Vice-Chairman—G. N. Cloos, Gregg N. Cloos Co., 977 Jackson, Denver, Colo.
Secretary—J. W. Ake, 416 S. Bemis, Littleton, Colo.
Board of Managers—G. B. Buck, III, G. H. Patterson, L. S. Reed, J. E. Watson.

St. Louis Section

Chairman—N. L. Krause, Sachs Electric Corp., 5540 W. Park, St. Louis, Mo.
Vice-Chairman—H. E. Thias, Union Electric Co., 315 N. 12th St., St. Louis, Mo.
Secretary—M. M. Buzan, 2219 Ibis Court, St. Louis County, Mo.
Board of Managers—B. Chassaing, W. N. Mangold, P. Q. Olschner, E. W. Stohlmann, Jr.

San Diego Chapter

Chairman—A. J. McCutcheon, Jr., San Diego Gas & Electric Co., 861 6th Ave., San Diego, Calif.
Vice-Chairman—P. O. Rich, Coast Electric Co., 744 "G" St., San Diego, Calif.
Secretary—W. M. Beery, 2560 First St., San Diego, Calif.
Board of Managers—G. L. Byrum, R. Gray, E. L. Peterson, B. A. Thyberg.

San Jacinto Section

Chairman—R. Putterman, R. A. Putterman Co., 4101 San Jacinto, Houston, Texas.
Vice-Chairman—R. Brentzel, 2501 Van Buren, Houston, Texas.
Secretary—W. Adam, 5649 Briar Drive, Houston, Texas.
Board of Managers—R. Burnett, D. Copeland, W. Henderson, H. D. Weisser, Jr.

San Jose Chapter

Chairman—Dale Jensen, International Business Machines, Monterey & Cottle Road, San Jose, Calif.
Vice-Chairman—Claude Perlewitz, Graybar Electric Co., 1376 N. 10th, San Jose, Calif.
Secretary—Jack Told, 1028 Lincoln Ave., San Jose, Calif.

Southeast Florida Section

Chairman—J. M. Hefly, 1310 Douglas Rd. #2, Coral Gables, Fla.
Vice-Chairman—R. H. Manley, The Studio of Lighting, 708 N.E. 1st Ave., Miami, Fla.
Secretary—C. K. Campbell, 1130 N. W. 41st St., Miami, Fla.
Board of Managers—H. K. Foster, G. H. Gill, E. M. Hickmann, A. K. Ries.

Southern California Section

Chairman—J. R. Jones, Westinghouse Lamp Division, 2834 E. 46th St., Vernon, Calif.
Vice-Chairman—J. N. Robertson, Department of Water & Power, 405 S. Hill St., Los Angeles, Calif.
Secretary—P. G. Chesebrough, Southern California Edison Co., 1324 5th St., Santa Monica, Calif.
Board of Managers—E. Balogh, L. Barrett, W. R. McMillan, Jr., A. Rowe, K. McLelland.

(Continued on page 34A)

Annual Meeting

In accordance with Article VII Section 1 of the Constitution of the Illuminating Engineering Society, the Annual Meeting will be held in conjunction with the National Technical Conference in St. Louis. The Meeting will take place at the Opening Session of the Conference, Monday, September 25, 1961, at which time the National Officers will report to the membership.

SOME LIKE IT HOT

Eight-foot G-E T10 Lamps are rated at 13,000 lumens peak output; T10J's at 12,900 lumens. Both are also available in four and six-foot lengths.

SOME LIKE IT COLD

THESE NEW GENERAL ELECTRIC ALL-WEATHER FLUORESCENT LAMPS LIKE IT WHETHER THE WEATHER'S HOT OR COLD

Now you can end "cold weather fade out" that hits regular fluorescent lamps. New G-E "All-Weather" Fluorescents are specially designed to perform well over a wide temperature range through winter and summer weather.

The General Electric jacketed lamp shown at left neither *looks* nor *acts* like an ordinary fluorescent. Its special glass "storm window" shields it against wintry blasts. Below 40° it's the most powerful fluorescent you can use. In fact, the colder it gets, the brighter the lamp gets —right down to 20° below zero!

So, if your customer's fluorescent lighting system must perform well under varying temperature conditions, or where low temperatures are a problem, you need All-Weather lamps. The Jacketed lamp (T10J) is designed for exposed locations. Its companion, the unjacketed lamp (T10), is made for use when the lamp is protected. Write for details on G-E "All-Weather" Fluorescents today. General Electric Co., Large Lamp Dept. C-114, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

ALC WINNERS in Miami Valley Section were Mildred Ditzel (second from left) for residential lighting and Tom Baughman (second from right) for commercial/industrial lighting. They are shown here with ALC Chairman, John Rupert (left) and Section Chairman, Paul Wehner.

(*Continued from page* 32A)

SOUTHERN COLORADO CHAPTER

Chairman—Lester A. Johnson, Pueblo Electric Supply Co., 131 Spring St., Pueblo, Colo.
Secretary—L. Rodney Rowe, 3002 Fourth Ave., Pueblo, Colo.

TAR HEEL SECTION

Chairman—J. L. Ponzer, Carolina Power & Light Co., Box 1156, Southern Pines, N. C.
Vice-Chairman—D. E. Rouse, P. O. Box 6504, Greensboro, N. C.
Secretary—W. F. Robinson, 5701 Preston Lane, Charlotte, N. C.
Board of Managers—R. Browning, J. Foreman, E. C. Gatewood, J. W. Vaughan, Sr.

TENNESSEE VALLEY SECTION

Chairman—W. E. Jones, Nashville Electric Service, 1214 Church St., Nashville, Tenn.
Vice-Chairman—J. N. Stansell, Stansell Electric Co., Inc, 209 14th Ave. N., Nashville, Tenn.
Secretary—F. S. Perkerson, Jr., General Electric Supply Co., 90 Peabody St., Nashville, Tenn.
Board of Managers—J. B. Holt, A. L. Jones, Jr., P. A. Paschall, W. N. Tune.

TORONTO SECTION

Chairman—A. J. Brown, 8 Thorn Lane, Don Mills, Ont.
Vice-Chairman—K. R. Ormrod, Powerlite Devices Ltd., 54 Atomic Ave., Toronto, Ont.
Secretary—L. H. Collins, 48 Chelford Rd., Don Mills, Ont.
Board of Managers—N. W. Bethune, D. E. McGregor, J. D. Mullock, H. B. Nellis.

TWIN CITY SECTION

Chairman—C. Duepner, B. M. D. & R. Lighting Inc., 7020 Walker St., Minneapolis, Minn.
Vice-Chairman—H. W. Spell, Northern States Power Co., 15 S. 5th, Minneapolis, Minn.
Secretary—L. G. Hamilton, Holophane Co., Inc., 217 Ninth Ave. N., Hopkins, Minn.
Board of Managers—J. Bahnak, R. K. Erdmann, R. H. Hamilton, F. Tillemans.

TWIN PORTS CHAPTER

Chairman—James C. Johnson, 245 W. Owatonna, Duluth, Minn.
Vice-Chairman—Glen J. Alden, Minneapolis Power & Light, 30 W. Superior St., Duluth, Minn.
Secretary—Carl G. Nelson, 1512 N. 45th Ave., E., Duluth, Minn.

UTAH SECTION

Chairman—W. C. Brown, 2843 LaJoya Drive, Salt Lake City, Utah.
Vice-Chairman—V. Proctor, 215 American Bldg., Salt Lake City, Utah.
Secretary—B. D. Glascock, 362 Utopia Ave., Salt Lake City, Utah.
Board of Managers—R. Carroll, P. W. Smith.

VIRGINIA SECTION

Chairman—R. W. Thomas, Chewning & Welmer, Inc., P.O. Box 4167, Richmond, Va.
Vice-Chairman—W. M. Amburgey, Jr., 4000 W. Broad St., Richmond, Va.
Secretary—G. Faison, 2507 Willard Road, Richmond, Va.
Board of Managers—A. E. Allen, W. M. Chandler, Jr., L. Reams, J. W. Sours, Jr.

WESTERN MICHIGAN SECTION

Chairman—J. Q. Miller, 1183 Hampden Rd., Muskegon, Mich.
Vice-Chairman—J. W. Gentry, Purchase Electric Supply Co., 700 Ottawa, N.W., Grand Rapids, Mich.
Secretary—A. B. L. Slenker, Consumers Power Co., 129-131 Pearl St., N.W., Grand Rapids, Mich.
Board of Managers—R. S. Ernsberger, K. H. Gelders, C. F. Kransvogel, G. D. Owens.

WESTERN NEW YORK SECTION

Chairman—C. S. Long, Jr., Sylvania Electric Products Inc., 601 Bailey Ave., Buffalo, N. Y.
Secretary—J. N. Kellas, Niagara Mohawk Power Corp., 535 Washington, Buffalo, N. Y.
Board of Managers—E. J. Cunningham, S. P. Filipetti, W. J. McCarthy, K. G. Priestap, R. Walters.

WINNIPEG CHAPTER

Chairman—F. Dehod, Northern Electric Co., Ltd., 590 Berry St., P.O. Box 668, Winnipeg, Man.
Vice-Chairman—J. D. Stephen, 400 Campbell St., Winnipeg, Man.
Secretary—D. E. MacPherson, 40 Arrowwood Drive N., W. Kildonan, Winnipeg, Man.

YANKEE SECTION

Chairman—A. E. Lacas, Western Massachusetts Electric Co., 48 Eagle St., Pittsfield, Mass.
Vice-Chairman—T. K. Haswell, Jr., 141 Birch Grove Drive, Pittsfield, Mass.
Secretary—R. W. Wyman, Graybar Electric Co. Inc., 32 Putton, Springfield, Mass.
Board of Managers—R. Coughlin, R. Knight, R. Smith, W. Wood.

YOSEMITE SECTION

Chairman—Glenn A. Baker, City Electrical Engineer, City Hall, P. O. Box 3068, Fresno, Calif.
Secretary—Masaru Yoshimoto, 4249 E. Parlier Ave., Fowler, Calif.

NEW MEMBERS

At the meeting of the IES Council on June 6-7, 1961, in New York City, the following were elected to membership. Names marked * are transfers from Associate Member grade.

CANADIAN REGION

BLUENOSE CHAPTER

Associate Member:
Harrington, M. H. F., Webber, Harrington & Associates, Halifax, N. S.

FOREST CITY (LONDON) CHAPTER

No Elections

GOLDEN WEST CHAPTER

No Elections

HAMILTON, ONTARIO CHAPTER

No Elections

MARITIME CHAPTER

No Elections

MONTREAL SECTION

Associate Members:
Labonte, J. P., Peerless Electric Ltd., Montreal, Que.
MacLellan, P. J., Dominion Tar-Chemical Co., Montreal, Que.
Lareau, E. D., Laureau Ltd., Montreal, Que.

NORTHUMBERLAND CHAPTER

No Elections

OTTAWA SECTION

No Elections

QUEBEC CHAPTER

No Elections

ST. MAURICE VALLEY CHAPTER

No Elections

TORONTO SECTION

Associate Member:
Kirk, W. J., Garcy Co. of Canada Ltd., Toronto, Ont.

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(*Continued on page* 36A)

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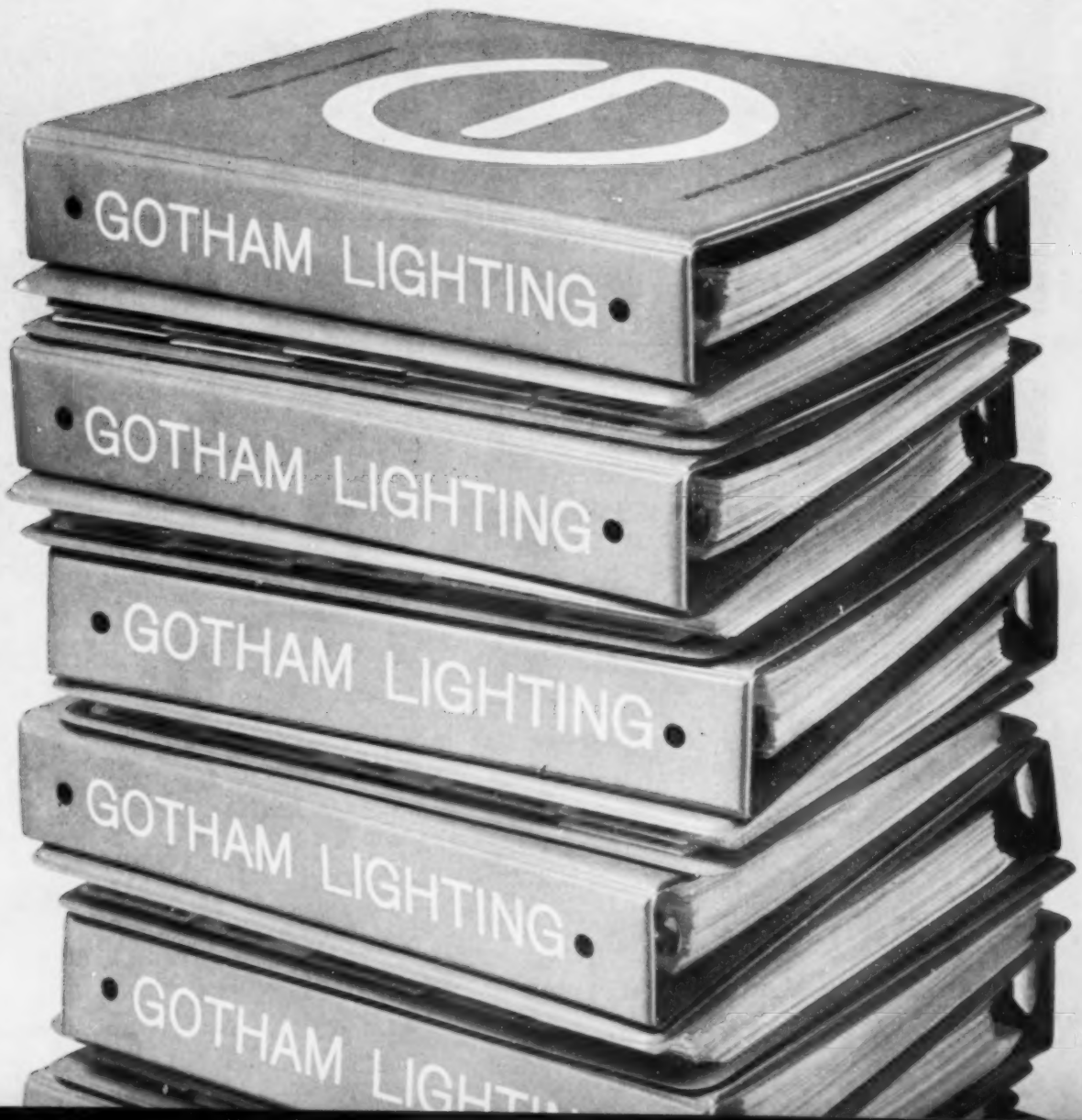

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square round

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(*Continued from page* 34A)

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(*Continued on page* 38A)

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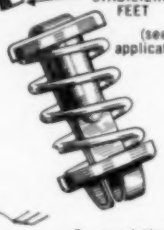
for removable panels and access doors

STABILIZING FEET (see application)



Completely assembled, installed in 5 seconds. Latch slips through hole, ring is snapped on. ¼ turn to operate. Spring tension eliminates noise transmission and vibration. Simple hole preparation. Eliminates riveting, screws, spot welding. Inexpensive.

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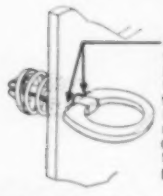
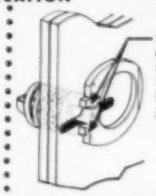


Ring held firmly upright by spring tension on feet extending into latch mounting cut-out preparatory to installing panel or door.



On completion of installation, ring held flat by feet extending beyond pivotal plane of ring.

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(*Continued from page 36A*)

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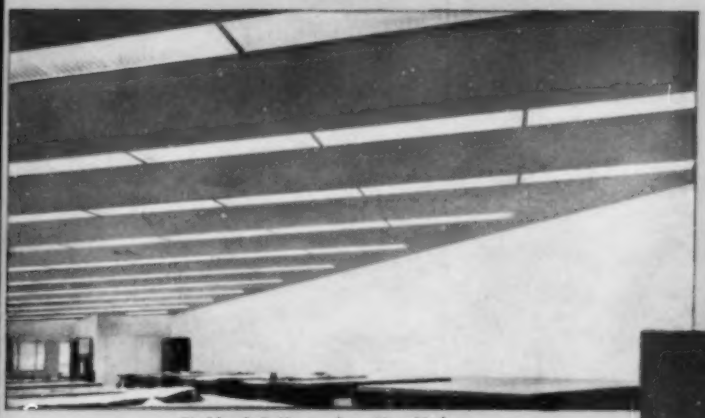

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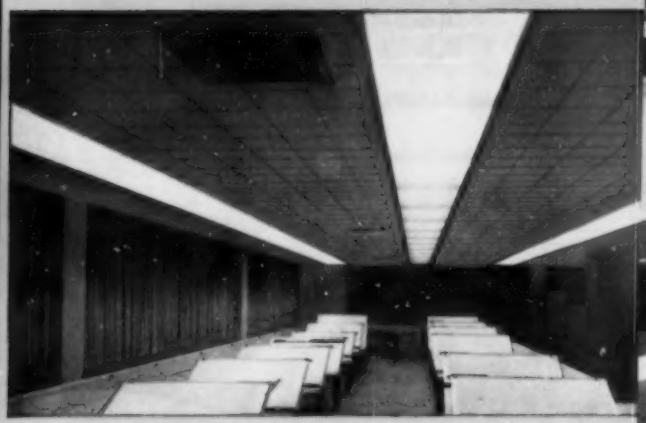

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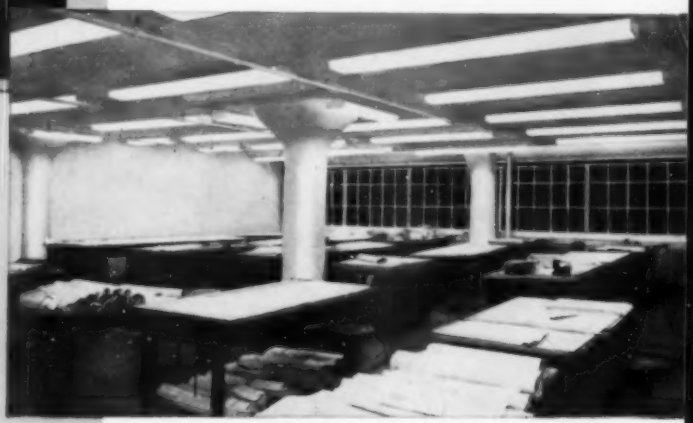

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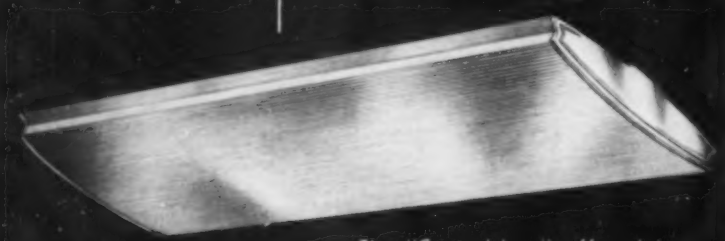

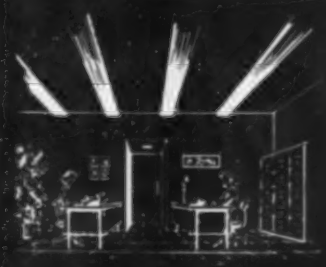

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(*Continued from page 38A*)

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(*Continued on page 42A*)

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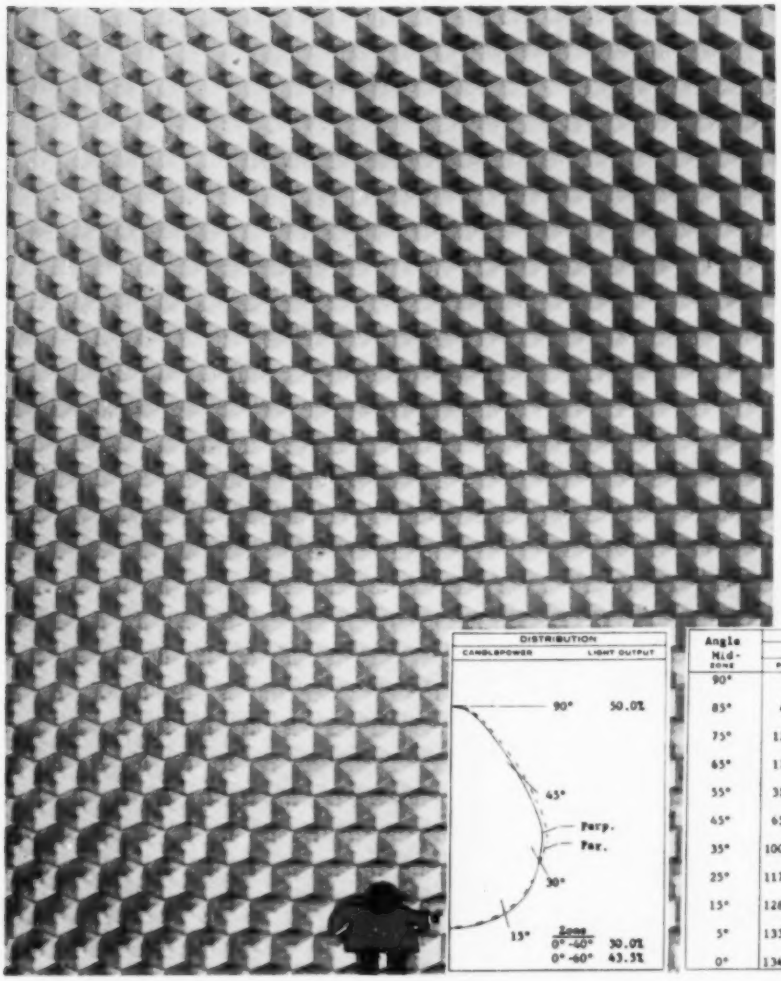

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75°	127		125		96.9	125
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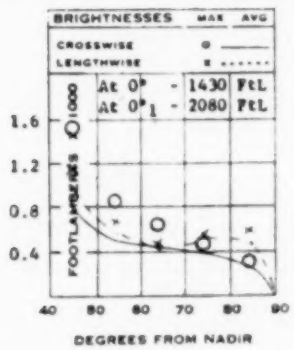
55°	317		313		279	274
45°	653		620		556	472
35°	1003		1000		970	625
25°	1177		1198		1196	551
15°	1281		1293		1301	365
5°	1334		1335		1338	127
0°	1341		1341		1341	-



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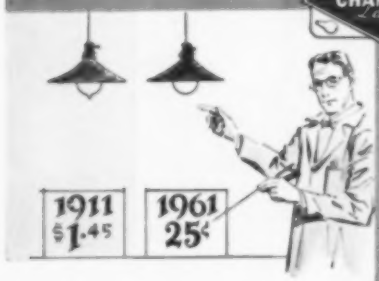

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Advance Transformer Co.	Inside Front Cover
Art Metal Lighting Div., Wakefield Corp.	Inside Back Cover
Champion Lamp Works	42A
Crescent Plastics, Inc.	44A
Crouse-Hinds Co.	23A
E. I. du Pont de Nemours & Co. (Inc.)	1A
General Electric Co., Large Lamp Dept.	33A
Gotham Lighting Corp.	35A
Edwin F. Guth Co.	Back Cover
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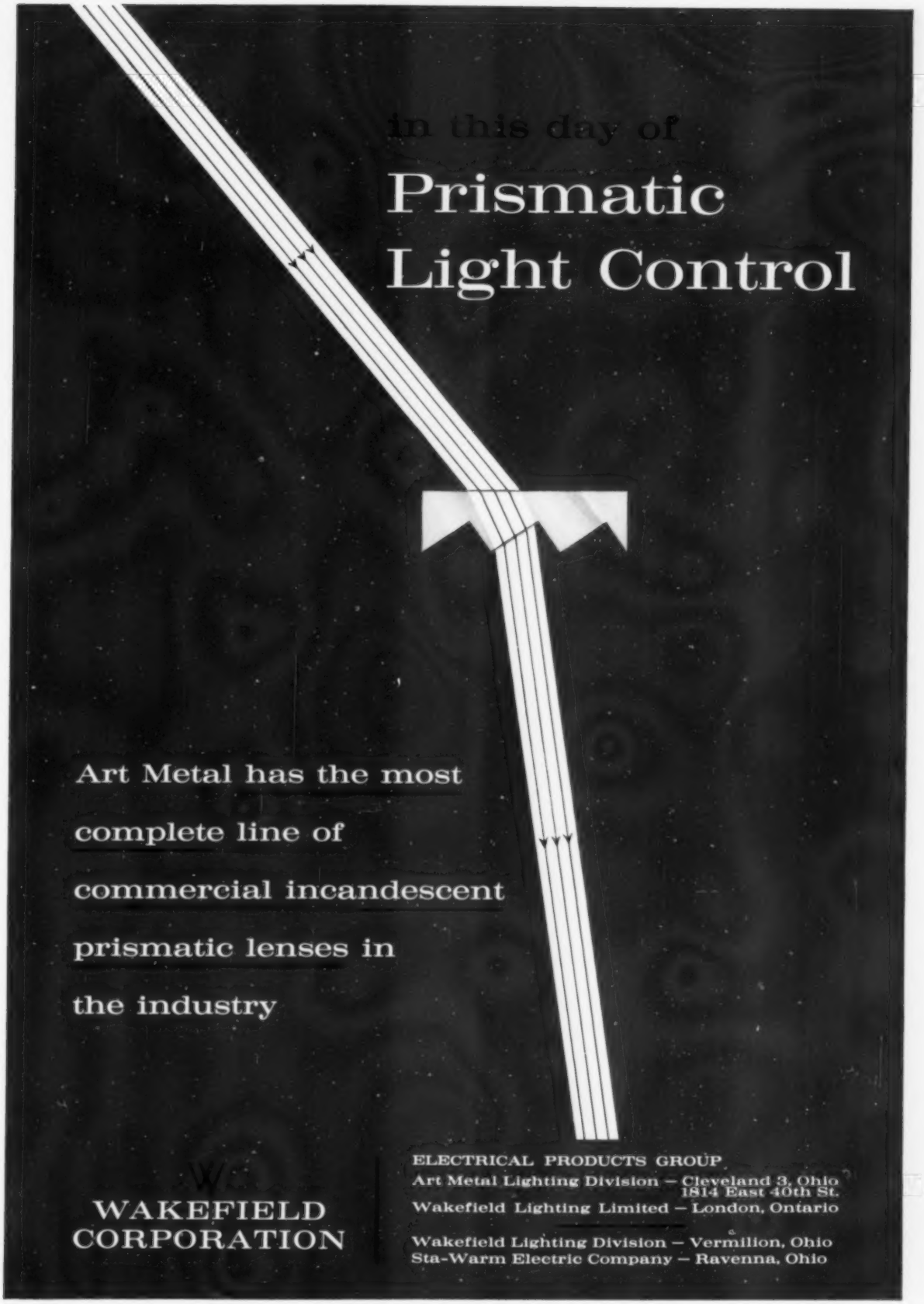
Kerrigan Iron Works Co.	2A
Kliegl Bros.	17A
Litecontrol Corp.	14A-15A
R. A. Manning Co.	38A
McPhilben Lighting Co.	36A
Mitchell Lighting Div., Compco Corp.	40A
Monadnock Mills, Sub. of United-Carr Fastener Corp.	38A
Monsanto Chemical Co.	18A
Photo Research Corp.	40A
Rambusch Decorating Co.	25A
Revere Electric Mfg. Co.	12A
Rotuba Extruders Inc.	41A
Sheffield Plastics, Inc.	4A
Sola Electric Co.	31A
Steel City Electric Co.	10A-11A
Sunbeam Lighting Co.	29A
Sylvania Electric Products Inc.	9A, 20A-21A
Union Metal Mfg. Co.	37A
Westinghouse Electric Corp., Lamp Div.	26A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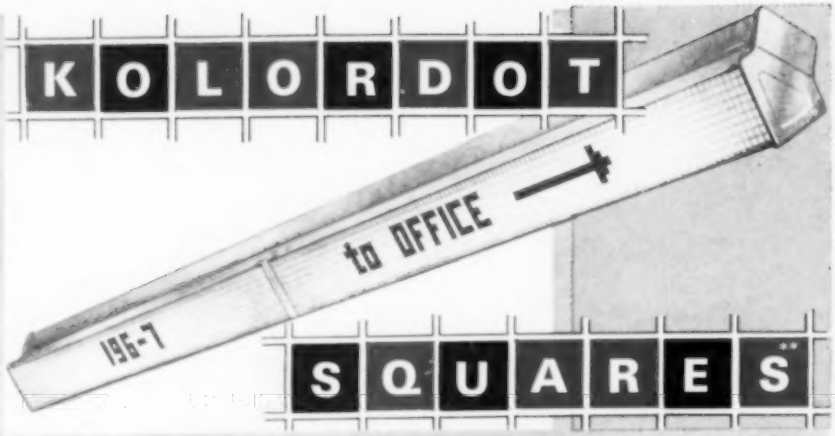
ACCENT the beauty of Gratelite* with* GUTH *Kolordots



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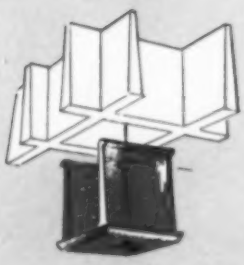
KOLORDOTS . . . versatile as the artist's brush. Just "snap, snap, snap" and you see words and designs or mosaic patterns come to life against the luminous glow of Gratelite . . . in ceilings or fixtures.

Four vivid colors — Sapphire Blue, Cardinal Red, Leaf Green and Vibrant Orange.

How can you use Kolordots? Just let your imagination go (and check the examples we show)!

KOLORDOTS *snap-lock into the ⅜" Gratelite cubes*



in four vivid colors

Point out departments, designate areas or rooms, or just "play Picasso!" KOLORDOT SQUARES will add new sparkle and beauty to your Gratelite ceiling or fixture.

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